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World's Largest Ice Skating Arena

EXHAUST STEAM FROM PUMPS UTILIZED IN AMMONIA ABSORPTION SYSTEM. COMPLETE CONTROL BOARD

RECENTLY COMPLETED FOR THE Chicago Arena Co., is the largest ice skating rink in the world, representing an investment of $520,000.

Housed in the main building, which covers an area 166 by 360 ft., is an ice floor 115 by 295 ft., consisting of a 2½-in. layer of ice which is maintained at the proper temperature regardless of the outside weather. The building was erected on land adjoining the Boyle Ice Co., whose motor-driven ammonia compressors supply 100 tons of refrigeration. Brine may be circulated through the skating arena floor from either plant, or any combination of the two plants employed. During the non-productive seasons, the commercial ice plant will boost the skating rink plant output which will in turn assist the commercial ice plant in carrying its load during the busier seasons.

FIG. 1. SKATING ICE SURFACE—CHICAGO ARENA

EXHAUST STEAM DELIVERED TO 125-TON ABSORPTION MACHINE

IN A separate building, 53 by 100 ft., is the skating arena power house, a plan view of which is shown in Fig. 3. Coal for the Detroit stokers which feed the boilers is dumped from trucks into a receiving hopper outside the boiler room. Thence it is carried by a Stephens-Adamson inclined bucket conveyor to a point between the stoker hoppers, from which it may be spouted into either furnace.

Steam at 125 lb. pressure, from either of 2 250-hp. Vogt return tubular boilers, is employed to operate the turbine-driven brine circulating pump, the aqua ammonia pump, the cooling tower pump, and the feed-water pumps. From the boilers, 6-in. leads fitted with Eclipse automatic stop and check valves are connected to an 8-in. header.

Exhaust steam from the pumps is utilized in the gen-

erator of the 125-ton Vogt ammonia absorption refrigeration system, and also for the direct heating of the numerous rooms and corridors of the building, tempering the arena air, and in melting snow scraped from the arena. When required, live steam may be drawn from the boiler room header through a 4-in. pressure reducing valve.

Feed water consists largely of condensate, the required make-up water being drawn from the city service main through an automatic control valve. After passing through a Cookson open-type heater and purifier, it is forced into the feed-water supply line by two 5¼ by 3½ by 5-in. Gardner feed pumps equipped with a Williams pump governor, the supply to the boilers being controlled by Williams safety feed regulators. Crane

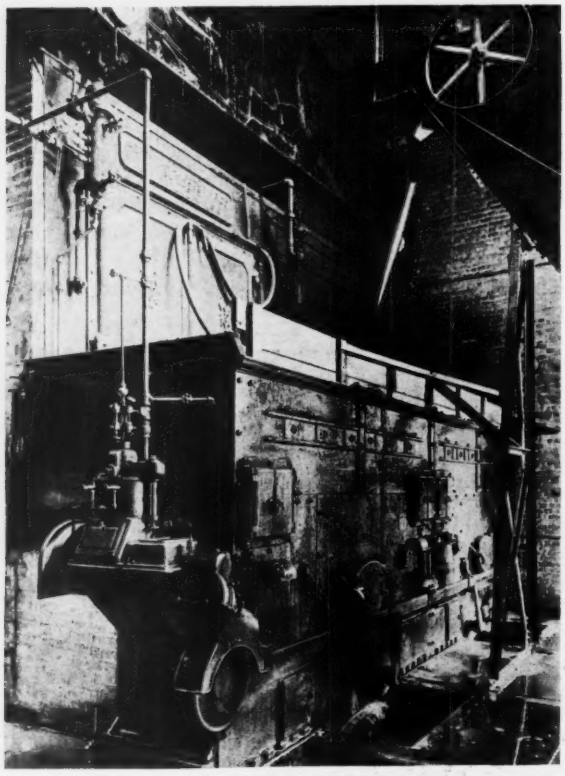


FIG. 2. BOILERS AND COAL CONVEYOR

fittings were employed, and National pipe was used throughout the plant, the ice floor included.

Duplicate Pumping Equipment

To take advantage of a low limited-hour current rate offered by a public service company, duplicate turbine-driven and motor-driven pumps were installed, the purpose being to use the motors when little exhaust steam is required, switching over to the turbine drives when considerable exhaust is required, or during the central station's peak load period. Incoming current is distributed from the switchboard shown in Fig. 4.

Ammonia gas is generated in a double cylinder generator, shown in Fig. 4. Each cylinder is 16 ft. in length and 44 in. in diameter, and contains straight evaporator coils of the return bend type, formed of 2-in. extra heavy wrought-iron pipe screwed into a header. An automatic regulator controls the flow of weak liquor from the generator.

Alongside the generator is an exchanger of the multitube type, consisting of 2 stands, 5 pipes high, each pipe 8 in. in diameter and 18 ft. in length. Adjacent to the exchanger is a multitube weak liquor cooler, and the multitube rectifier, 6 pipes high, is placed on the roof.

The absorber is of the horizontal tubular type, 5 ft. in diameter and 20 ft. in length, and the brine cooler

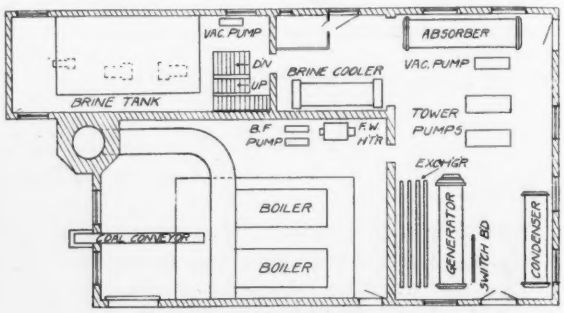


FIG. 3. PLAN VIEW OF POWER HOUSE

is of similar design, 50 in. in diameter and 12 ft. long. Two ammonia condensers, of the horizontal shell-and-tube type are provided, each 42 in. in diameter and 16 ft. long, one being mounted above the other.

Pumping Equipment

Aqua ammonia is pumped by a steam-driven, double-acting simplex pump, 16 by 7½ by 16 in., which is controlled by a Mason governor. Circulating water for the Burhorn cooling tower on the roof is raised by 2 Fairbanks-Morse 5-in. centrifugal pumps, one driven by a 30-hp. induction motor, the other by a 30-hp. Sturtevant turbine, each having a capacity of 500 gal.

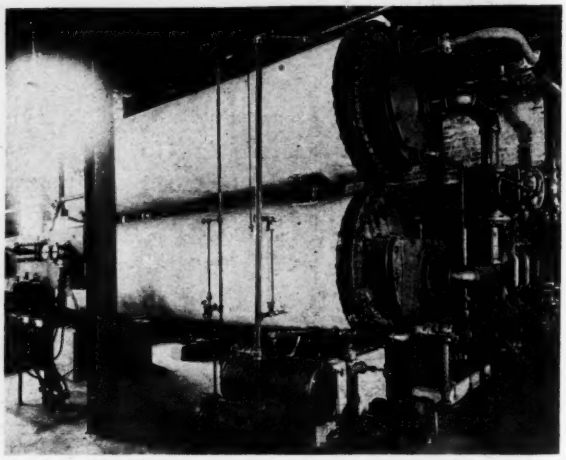


FIG. 4. AMMONIA GENERATOR AND EXCHANGER

per min. against an 80-ft. head. Vacuum for the heating system is provided by a Marsh pump, equipped with an Eclipse regulating valve, a pressure of about 5 lb. being ordinarily carried.

On a level 6 ft. below that of the engine room is the base of the 3 brine circulating pumps, which connect to the 10-in. line from the arena brine cooler at one end, and to the 10-in. lines from the Boyle Ice Co. plant

at the other end. As shown by the piping diagram of Fig. 6, the arrangement is such that the brine flow may be reversed through the ice floor or any combination of the refrigeration of the 2 plants may be employed. To circulate the brine through the ice floor, brine cooler, etc., duplicate 8-in. Fairbanks-Morse centrifugal pumps are used, each having a capacity of 1500 gal. per min. against a head of 60 ft. One is operated at 1600 r.p.m. by a 40-hp. turbine, and the other at 1200 r.p.m. by a 40-hp. a.c. motor. Brine for the bunker coils of an air cooling chamber in the arena is delivered through a 4-in. line, circulation being effected by a 4-in. motor-driven centrifugal pump.

Located on an intermediate floor above the brine pumps is a brine storage tank, 20 by 12 by 6 ft., and a brine surge and mixing tank, 30 in. in diameter and 6 ft. high.

Ice Floor

Extending across the ice floor are 20.1 miles of 1-in. pipe spaced on 4-in. centers. This piping was laid directly upon the ground and rests upon 4 by 4-in. creosoted sleepers, spaced every 7 ft. the full length of the rink, which in turn rest upon short lengths of 2 by 6-in. creosoted sleepers.

Brine is supplied through 8-in. headers of uniform size over the entire length of the rink. From one brine header the brine rises into 3-in. supply headers, 6 ft. in length, each feeding 18 pipes across the rink floor. Similar supply lines on the opposite side receive the brine and feed it up into another 8-in. header. To prevent one end receiving more refrigeration than another due to short-circuiting, one of the 8-in. mains runs the full length of the rink and is doubled back again, as shown in Fig. 7.

Smoothing the Ice Surface

Following each of the 3 daily skating sessions, the ice is smoothed off by a tractor-drawn planer, current for the 10-hp. tractor motor being secured through a cable suspended from the center of the roof. To prevent twisting of the cable as the tractor encircles the arena, the cable is revolved by a motor on the roof, which is controlled from the tractor seat. Snow formed by the planer is collected by a scraper and dumped into a pit at either end of the rink, which contains water heated

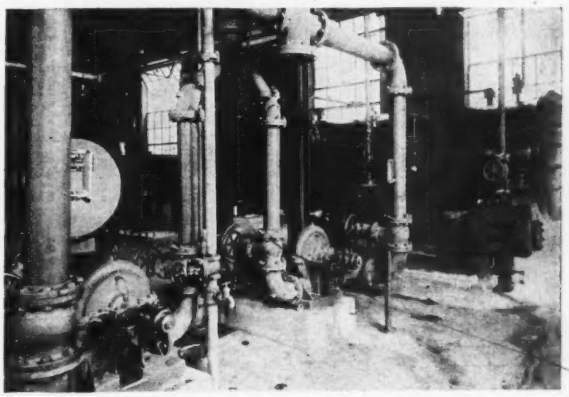


FIG. 5. WATER TOWER PUMPS AND ABSORBER

by exhaust steam to melt the snow before discharging it to the sewer.

After planing the ice, it is usually "rubbed down" by playing a hose stream over the surface and then rubbing it off with squeegees. This process, which removes all fine particles and fills any possible cracks, is followed by applying an extremely fine spray which forms a uniformly smooth surface when frozen.

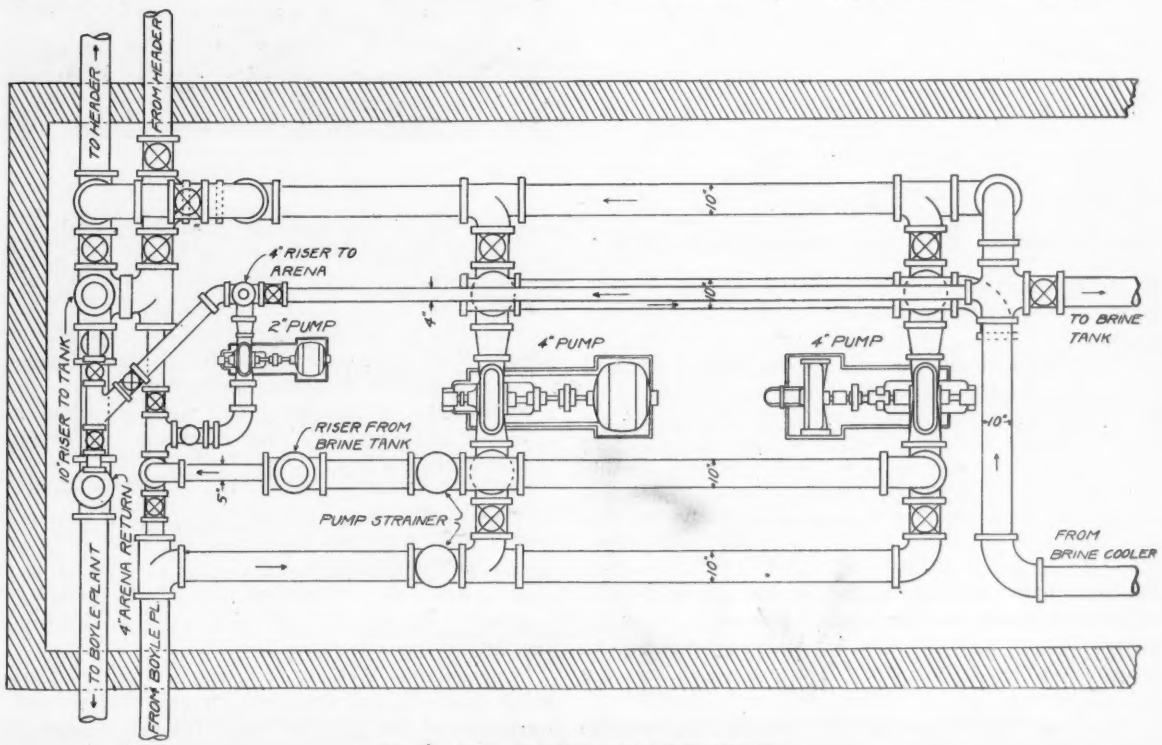


FIG. 6. ARRANGEMENT OF BRINE PUMPS

Air Conditioning

To maintain a proper condition of the ice, it is necessary to maintain an almost constant air temperature, from 50 to 52 deg. F. being the ideal.

Located in 2 diagonal upper corners of the arena are heating rooms, each of which is equipped with 1012 sq. ft. of exhaust steam coils, the combined condensation amounting to approximately 3200 lb. per hr. The coils are formed in 3 units, each or all of which may be bypassed by means of air valves from a central control board. These warming chambers are equipped with 36-in. Sirocco fans and each is capable of delivering 3400 cu. ft. of warm air per minute.

In another corner of the arena is the air cooling chamber in which are placed 14 stacks of 1-in. pipe, 27 pipes high and 40 ft. in length, the stacks being set 14 in. apart. After passing among these bunker coils, which ordinarily have a 3 or 4-in. coating of ice, the

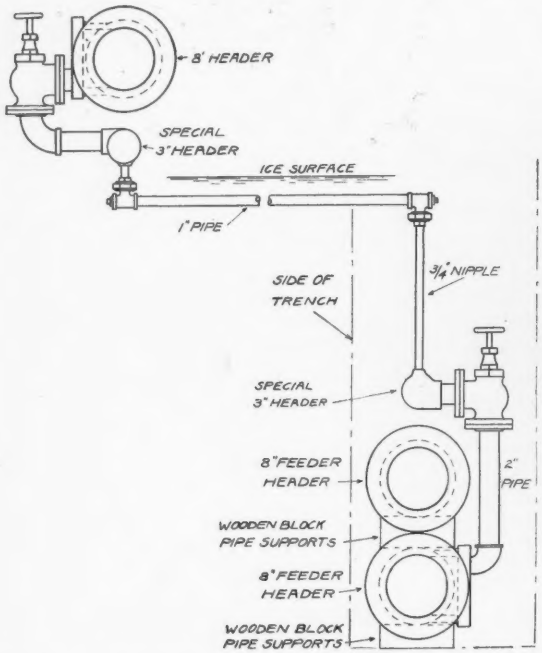


FIG. 7. BRINE HEADER CONNECTIONS FOR ICE FLOOR

air drawn from the arena is returned through a 12-ft. American Blower Co. ventilating fan, driven by a 25-hp. a.c. motor.

Six 42-in. Ventura booster fans, one on each side and 2 at each end of the arena, each operated at 450 r.p.m. by a 2-hp. a.c. motor, are provided to take up the air and maintain a circulation. Each of these fan chambers has a gate which permits it to draw air from outside or from the rink, all being operated by air control valves on the switchboard in the control room.

Control Board for Ice and Air

Invariably one associates ice skating with zero weather, but that is only when nature is relied upon to provide the ice. Here is a notable example of an improvement on nature, for the arena ice and air are made to order.

As it is highly important that ice surface be maintained in a uniformly tempered condition, a control system developed and patented by Dudley Scott, of Cleveland, is employed. In brief, its purpose is to maintain, under all conditions, a temperature of the body of the ice between 20 and 24 deg. F., with a maximum of 27 deg., while the surface is held near the melting point. Having the surface ice near the melting point, secures a condition which makes the skates glide most easily, and also prevents an accumulation of snow and chipping of the ice which results from a surface that is too cold.

To maintain proper ice, a number of conditions must be watched, such as the outside temperature, the humidity of the air, the thickness of the ice, etc. Imbedded in the ice at different locations in the ice floor are 4 electrical resistance thermometers. Electrical thermometers are suspended from the roof and also placed in the brine circulating pipes. Temperatures at these and other points are indicated on the 5-panel control board, shown in Fig. 8, which is plainly visible from the arena through plate glass windows. Air control valves for the regulation of the building radiators and for the

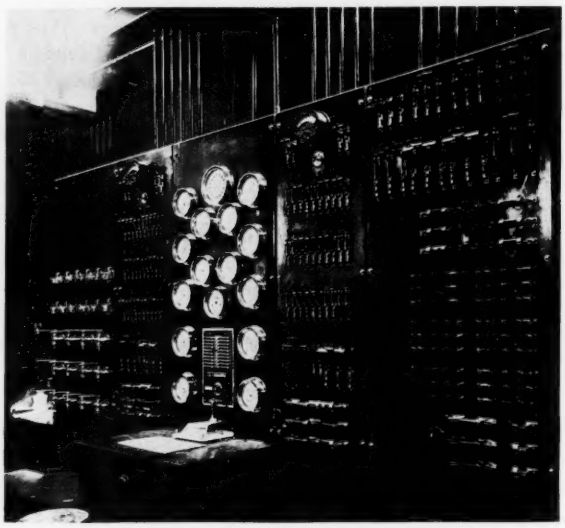


FIG. 8. ICE ARENA CONTROL BOARD

operation of the fan chamber gates are placed on the first panel. Lighting switches are located on 2 panels and power switches on a fourth panel. Mounted on the central panel is an electric pyrometer, which may be connected in circuit with any of the electrical thermometers. Other instruments provided on this panel are: Pressure gages for the steam, air, water and brine lines, a hydrometer, a barometer, and wind direction indicator. A daily log of all temperatures and other important conditions is kept.

It is proposed to operate the arena for public ice skating until in May, when the building will be provided with a false floor over the piping and used as an auditorium or hippodrome, the cooled air forming an attractive feature. As previously mentioned, the refrigerating equipment will also be used to assist in the ice production of the Boyle Ice Co.

Carpenter & Weldon, of Chicago, were the refrigerating engineers and architects for this project, and the operation of the plant is under the direct supervision of T. S. Danks.

Injectors

THEORY, CONSTRUCTION AND OPERATION OF VARIOUS TYPES

TO Giffard, the eminent French engineer, much credit is due for inventing the simplest apparatus for feeding boilers that has ever been devised, utilizing in an ingenious way the latent power of a discharging jet of steam. Much of his time after he left college in 1849 was spent in developing a light steam motor for propelling balloons. It is not surprising, therefore, that he attempted to devise a compact and convenient substitute for steam pumps, and in 1858 he was granted a patent on an injector.

The English locomotives opened a wide field for the injector, for upon most of the locomotives, the earliest feed pumps were operated by hand, but afterwards were coupled to a special eccentric or to the crosshead. In 1860 the injector was introduced in the United States by Wm. Sellers & Co., who commenced its manufacture in Philadelphia, and shortly afterward the injector was successfully applied to American boilers.

Although the curves of the tubes and nozzles as designed by Giffard were correct, added information regarding the action of steam during expansion, and minor modifications for economy of manufacture, or for adapting the injector to special purposes have made necessary certain changes in construction.

As a comparison with the original form of injector shown in Fig. 1 will indicate, the general appearance of the injector as now constructed is quite different from the early type; the arrangement of the adjusting handles, odd-shaped body, heavy flanged pipe connections and steam cock do not contrast favorably with the present forms of injectors used on American boilers.

Since the heat in steam drawn from the boiler is returned to the boiler, except the very small part which is used in doing work, it is evident that the thermal efficiency of an injector is nearly perfect, but its mechanical efficiency is low; and its use is ordinarily restricted to cold or moderately warm water.

Delivery Tube

IT IS DESIRABLE that the delivery tube should be gradually enlarged from its smallest diameter to the exit in order that the water in it may gradually lose velocity and be less affected by the sudden change of velocity where this tube discharges to the pipe leading to the boiler. A sudden change in the velocity is undesirable, as the tube is worn and roughened at the point where the change occurs.

It has been experimentally determined that, with a steam pressure of 65 lb., a converging delivery tube cut short at the smallest section would deliver water against 35 lb. pressure, a cylindrical tube 4 times as long as the internal diameter would deliver against only 24 lb. A tube with a rapid flare delivered against 62 lb., and a gradually enlarged tube delivered against 93 lb.

Injectors are commonly rated by the size of the delivery tube; thus a No. 6 injector may have a diameter of 6 mm. (0.2362 in.) at the smallest section of the delivery tube.

Single-Tube Injector

DERIVING its name from the fact that it employs but one steam jet, the single-tube injector shown in Fig. 2 is the simplest form.

When steam is admitted, it passes from the steam jet, A, into the combining tube, B, and out of the overflow, E. In passing from A to B, the steam carries with it the surrounding air, which induces a partial vacuum above the water supply. Water will then rise in the supply pipe, D, and begin to flow into the injector with a velocity which is proportional to the vacuum produced. The high velocity steam strikes the cold water, condenses and imparts to it most of its momentum in addition to virtually all of its heat. With its increased momentum, the water produces a pressure on the check valve, F, which opens and allows the water to pass as soon as a sufficient momentum has been acquired. With the opening of the check valve, the stream through the overflow ceases simultaneously, and the entire supply enters the boiler.

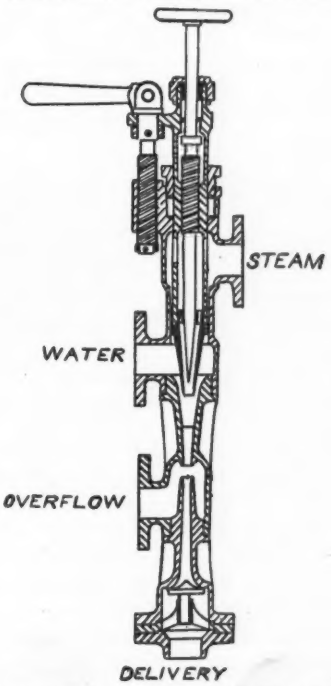


FIG. 1. VIEW OF A MODIFIED GIFFARD'S INJECTOR

Due to their inability to lift water, single-tube injectors must receive their supply from an elevated tank or under pressure.

Double-Tube Injector

BY ARRANGING 2 jets, one behind the other, it is possible to add their individual forces and overcome resistances impossible or impracticable with a single-tube injector, a principle which has found wide application in the positive or double-tube type. An ideal form of the double-tube or compound injector is shown in Fig. 3.

In practice, however, the energy of each steam jet is applied directly to performing only one of the functions of the injector; to the first tube is given the task of lifting the water and causing a flow through the

injector, and it is termed the lifter; the duty of the second jet is to force the water into the boiler, and it is, therefore, called the forcer.

To make each of the tubes more efficient for its particular purpose, the finer points of design relative to the shapes, sizes and lengths of the tubes must be considered. Steam is first admitted to the lifter or lower jet, until a steady continuous stream of water is observed at the overflow. When this is established and regulated, the forcer is opened slowly until the overflow ceases, which indicates that the boiler is receiving the water.

Lifting injectors are classified as positive or automatic in operation. When the flow in the positive type is interrupted, it is necessary to shut it off and start it again by hand. With the automatic injector, if the flow of water is broken for any reason, it will automatically build up again.

Manual Control Injector

Regulation for starting of the early types of injectors was obtained by hand control, the amount of steam allowed to pass through the steam nozzle being controlled by a needle valve. To start the water flowing to the instrument, it was necessary to cut the supply of steam down to such a point that it would all pass through the combining tube and out of the overflow;

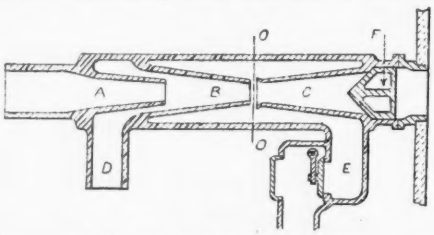


FIG. 2. SINGLE TUBE INJECTOR

for if more than this amount be supplied, the resistance of the combining tube will cause the steam pressure to back up and destroy the vacuum which should be formed to lift the water. Once the water has been lifted to the combining tube, the steam is condensed as rapidly as it issues from the nozzle, and the steam valve is then completely opened to give the combined stream force enough to drive it into the boiler.

Automatic or Restarting Injector

Injectors of the automatic type have been developed to overcome the inconvenience and waste of steam which results when the supply of water is temporarily interrupted or the steam pressure suddenly lowered. When this occurs and water fails to reach the combining tube, it is necessary to manipulate the regulating valve before the instrument will again deliver water to the boiler.

In automatic injectors, the form of the combining tube has been altered, slightly, from the simple type in order that all the steam which issues from the nozzle when the valve is wide open may pass directly through the combining tube to the overflow when no water is present to condense it, thus forming a partial vacuum in the water chamber which causes the water to be lifted to the instrument.

One method of re-establishing the flow of the stream of water consists of dividing the combining tube into 2 parts with an open space between, which is sufficiently large to allow the steam to pass without banking up the water space when the steam valve is wide open. With this arrangement, what steam cannot pass through the entire length of the combining tube passes out to the overflow through the check valve, which closes immediately when water reaches the injector.

Capacity

The capacity of an injector is dependent on (1) The steam pressure carried. Where the pressure is apt to vary, the limits of fluctuation must be known. (2) Temperature of the water supply. (3) Location of water supply; whether it will flow to the injector or requires lifting. (4) The service; the nature of the water; the jars the injector must stand, etc.

For any boiler feeding purpose, it is poor policy to select an injector of just sufficient size to meet the requirements. It is well to provide an over capacity of from 30 to 50 per cent, for the reason that the operation is liable to be impaired, in time, by corrosion, wear from gritty water, varying steam pressure, scale, or increase in the lift.

There is one predetermined steam pressure at which the capacity is a maximum; a decrease or increase in pressure from this point involves a decrease in capacity. The range of pressure through which the injector will operate is located between the pressure at which water will just be lifted and forced into the boiler, and the pressure at which all steam will not be condensed,

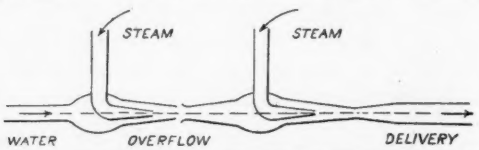


FIG. 3. IDEAL ACTION OF DOUBLE TUBE INJECTOR

but some be wasted by blowing through the overflow.

An increase in feed water temperature decreases the height to which water can be raised by the injector because the water can condense less steam, making necessary a reduction in the steam pressure which may be carried, and thus reducing the range of the injector. Remembering that the degree of vacuum limits the height to which water may be raised, a study of the following table will show the value of cool feed water:

Vacuum In. Mercury	Water Temp. Deg. F.	Theoretical Lift, Ft.	Practical Lift. Ft.
0	212	0	0
11	190	12.4	8.8
18	170	20.4	14.4
22.5	150	24.8	17.6
25	135	28.3	20.0
27.5	112	30.5	21.0
29	72	33.0	23.5
29.5	52	33.5	23.8
30	40	34.0	24.0

Working Conditions

If a high steam pressure is to be carried, the double-tube injector is the proper selection, as the high temperature of a boiler delivering high pressure steam demands a feed water as hot as possible for both economy and safety.

On traction, hoisting and similar engines, jarring and shaking will break the stream in the injector, and the frequency with which this occurs, limits the selec-

tion of a suitable injector to the automatic type, whose ability to restart, upon interruption, has given rise to its being termed the "restarting" injector.

Operating Notes

When connecting an injector, care should be taken to blow out all the piping and free it from scale, red lead or other substances which might clog the nozzles. In case the injector fails to work, it should be disconnected, the cap or plug removed and the tubes or nozzles cleaned. When it fails to lift water, the trouble is usually due to an air leak in the suction pipe. If it lifts the water easily but will not force it into the boiler, examine the boiler check valve, and also see that no dirt or scale has lodged in the tubes.

Another cause of failure is the choking up of the overflow, due either to the accumulation of sediment or to poor pipe connections which do not permit an unobstructed passage for the steam and water.

When the injector starts properly but breaks the vacuum, it indicates that the supply of water is not properly regulated, or a leak exists in the supply pipe or, the disk of the steam valve is loose. If the supply pipe becomes very hot, it should be cooled with cold water.

Ejectors

For draining or raising large quantities of water a small height, an instrument known as an injector can be used with a comparatively small expenditure of steam.

Unlike the injector, inasmuch as it does not depend upon the expansion and condensation of a gaseous fluid acting within clearly defined limits, it can operate with any gas or any liquid in conjunction with any other gas or liquid.

In the case of an injector, the cross-section of the discharge nozzle of the actuating jet is greater than that of the receiving or delivery tube. This condition is reversed in an ejector, and the gaseous or liquid discharge will pass freely through the delivery tube. The proportions of the parts of an ejector vary somewhat with steam and counter pressure, and the purpose for which it is to be used; the ratio of the steam orifice to the delivery tube may vary from 0.25 to 1.00, to 0.8 to 1.00, the former ratio giving a strong suction in a well-shaped tube at the higher steam pressures.

(To be continued.)

Handling Lubricants--II

Oil Storage and Accounting for Large Plants. By John Rome Battle*

THE storage and checking of oils and other lubricants required in large plants and industrial operations demand slightly more complicated arrangements than those recommended for the small plant; but these arrangements are really only enlargements of those used in the small plant.

The most important factor to be dealt with is the location of the oil storage. It must be centrally located with respect to the distribution of the equipment requiring lubrication and a separate oil house should be provided if possible. If the plant is widely spread out, as is the case of a ship-yard or steel plant, the oil house should be located centrally with respect to the acreage of the plant.

If the plant is not large enough to warrant carload shipments of even mixed grades of lubricants provision must be made for unloading trucks and wagons. A suitable platform which, in the case of a railroad delivery should be of sufficient size to allow at least 65 bbl. of oil, which is a minimum railway carload, to be placed on it at one time, and in the case of wagon delivery, of at least 25 bbl., must be provided.

A suggested plan for an oil house equipped to handle the lubricant requirements of a large operation is shown herewith.

For this oil house the platform is of sufficient size to carry either a full carload, or truckload, as the case may be. The advantage of such a platform is evident in the quick emptying of a freight car with a minimum of effort to prevent demurrage. For truck delivery the platform should be slightly lower. In some oil houses there is no platform and the barrels must be removed from the truck or car on skids. This condition is very unsatisfactory and often results in the barrel receiving such a strong jolting that it leaks.

Directly inside the door of the oil house the scales are located so as to make the checking of the delivered oil easy.

It is well to provide a small office, as is shown, for the use of the man having charge of the oil stores; this will encourage him to keep his oil records in much better shape. A good plan is to locate the pump handles for bringing the oil up from the tanks, inside the office, so that only the oilhouse man who has the office key can pump oil. The outlets from the pumps may be located outside of the office partitions, as is shown, so that no one except the oil-house man needs to enter the office.

A well designed oil-house office should be provided with an orderly oil sample case for the preserving of samples of current deliveries of oil and for reference in case a selection of oil is required by a workman for some unusual purpose.

For the small or medium sized plant the cellar tanks may be dispensed with, and the equipment, such as is shown in Fig. 2, page 381, May 1 issue, may be used to store the oils on the main floor; however, for large storage, the cellar tanks are the best.

The tanks should be equipped with an air vent, as is shown. All of the oil lines must have a good pitch toward their respective tanks to insure draining. The fill boxes, or outlets, should be located at least 3 ft. out from the wall to permit entire freedom when handling the barrels.

The cylinder oil and black oil tanks should be equipped with steam coils, having a valve located on the main floor, so that the oil may be heated in cold weather.

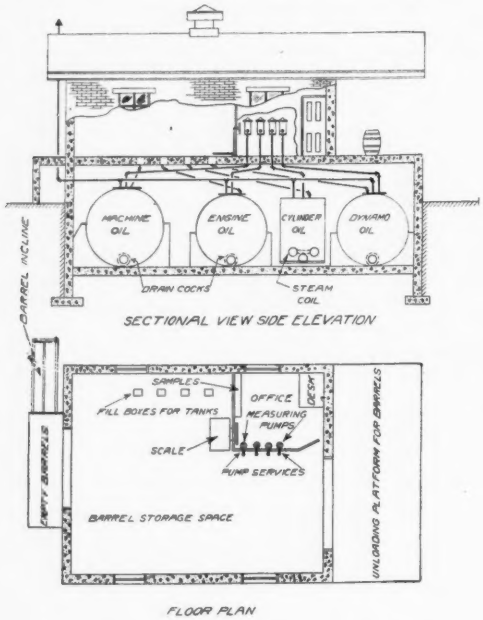
In large plants where torch oils and lubricating oils are received in large quantities, and often in tank cars,

*Author Battle's Handbook for Lubricating Engineers.

fill lines should be run out to the middle of the adjoining railroad track and to one side of the barrel unloading platform. This will enable tank cars to be unloaded without interfering with the deliveries of barrel lots.

If the oil house is equipped with a concrete floor the barrels should always be rolled over skids to prevent damage. The oil-house should be equipped with a cooper's hammer and a driver for tightening leaking barrels.

The accounting for the oil used in a large plant is an important factor in reducing the cost of lubrication.



SUGGESTED ARRANGEMENT FOR OIL HOUSE

The best plan to follow is to have a rule requiring that each man getting oil must fill out a requisition slip. A suitable form for this purpose is outlined:

OIL-HOUSE REQUISITION SLIP

Date..... Department.....
.....Oil .....Gallons
.....Oil .....Gallons
.....Oil .....Gallons
.....Grease .....Pounds
.....Torch Oil .....Gallons
Name..... Machine.....

These forms should be gotten up in the form of a cheap pad and the pad kept hanging on the office wall. By reference to these slips the responsibility for the oil and other lubricants used can be definitely placed. This system will provide a check upon the oiler and will prevent the use of the wrong lubricant on any machine. The tendency among workmen is to use the highest priced lubricant for their machines regardless of whether a cheaper form of lubricant would do the work satisfactorily.

In a medium sized plant it will be sufficient to appoint one of the oilers to have charge of the oil storage and slips, but in a large plant a special man is required.

For large plants the slips should be kept on a file and totaled up each week, when a report should be made out showing the condition of the stores and the weekly amounts used.

In a well organized plant that came under the writer's notice these special reports were made up in pad forms so as to give one white original and three colored copies. The first sheet, which was white, was sent to the general manager's office. The second sheet, which was yellow, was sent to the purchasing agent's office. The third sheet, which was blue, was sent to the accounting department, and the last copy was retained by the oil-house for records.

This plan proved to be very good. The general manager's office could see at a glance the cost and efficiency of the plant lubrication. The purchasing agent had an accurate statement of the stock of each grade of lubricant on hand and thus was enabled to keep his orders well ahead of the exhaustion of the stocks, so that the question of delivery did not hamper him in getting good prices when purchasing. The slip sent to the accounting department, when attached to the purchasing agent's voucher, made a complete reference for their accounts and the last slip gave a current record at the oil-house. A specimen form of one of these reports is as shown.

This is a particularly good form of report, and as can be seen, the number of empty barrels of each grade are shown, which is of value to the accounting department in adjusting their account with the oil company and securing the proper credit for the returned empty barrels.

I have endeavored in this article, to outline some general methods for handling, accounting for, and storing lubricants and to impress upon the mind of the reader the importance of this phase of the lubricating routine of the average plant.

WEEKLY OIL HOUSE REPORTS

WEEK BEGINNING 12/12/16 WEEK ENDING 12/19/16

	GALLONS					
LOCATION	#1 Cylinder	#2 Cylinder	#1 Engine	#2 Engine	Grease	Black
Main Machine Shop	--------	------	195	144	75#	----
#1 Power House	69	75	------	90	----	----
#2 Power House	112	98	70	340	35	----
Electric Cranes #(__)	--------	-------	25	----	10	160
Pneumatic Tool Room	--------	-------	------	45	568	----
Motor Truck Garage	--------	-------	------	160	----	----
Plate and Angle Shop	--------	-------	70	----	90	675
Stock On Hand Last Report	365	275	479	1760	1500	1309
Total Used This Week	181	175	360	949	778	835
Stock Remaining On Hand	184	102	119	811	722	474
Total Oil On Hand Including Deliveries	534	302	1008	1356	2078	1456
Empty Barrels on Hand	8	17	18	19	6	19

SIGNED BY J. V. SMITH.

Every plant superintendent and operating engineer will find that a systematic handling of the lubricating products used in his plant will not only result in a concrete saving in the lubricating costs due to the reduced waste of oil, but also the increased satisfaction arising from a cleaner and more orderly plant will return much profit for the time and money expended in obtaining this result.

Am I Wasting Coal?*

COAL IS SCARCE. PRICES ARE RISING. ARE THERE HEAT LEAKS IN THIS PLANT? SOME WAYS TO STOP THEM. BY JOSEPH W. HAYS

EVERY business man is vitally interested in the cost of heat, light and power. Why is coal high at the present time? Because the stocks in all yards are low and this in turn has been due to a car shortage. Cars are not to be had because some of them stand loaded upon side tracks at the seaboard terminals, and because heavy tonnage demands keep other available cars moving. Many coal mines are working on short time.

"Give us cars," say the mines, "and you can have plenty of fuel."

"Tell us where to get the cars," say the railroads, "and you can have them."

The owner of a steam plant, who is buying 200 tons of coal a day, and the owner of the house heating furnace, who is buying 2 tons of coal a month, can do little, if anything, to change the tonnage prices they have to pay. But they can do a great deal to reduce the quantities they have to buy.

It is quite safe to say that coal consumers, big and little, waste one-fourth of the fuel they buy. I do not know what the average consumer pays for his fuel; however, bituminous coal today is worth a dollar a ton at the coal mine. The remainder of the price we pay represents freight and middlemen's profits. It is evident that the farther the power plant is from the mines, the more the plant must pay for its fuel; for that reason, these plants should study fuel economy.

IMPORTANT TO WATCH THE LITTLE WASTES

WHAT CAN BE DONE to overcome this great waste of fuel? Fuel economy depends upon little things. The first thing to do is to find the little things, and then to apply the remedies that will produce the desired large result.

The manager of a factory recently said: "I feel that I owe my company $25,000. We have just discovered that we can make a clear saving of $5000 a year in our fuel bill and we are actually making it. The entire cost of it was liquidated by our first month's savings. I have had charge of this factory for 5 yr. What I have just done I might have done 5 yr. ago had somebody made me realize that we were throwing away money in our boiler room."

As a rule, the managing executive in a concern lacks engineering knowledge and experience. He employs one or more engineers and relies upon them. If the coal bills are too high, you will probably find the explanation in the boiler room where the fuel is burned.

The phenomenal growth of the central station as a dispenser of light, heat, and power is perhaps explained by this lack of interest of managers in the fuel account. The central station makes power to sell and must make it economically in order to sell it at a profit. The isolated plant makes power to use and often the manager regards his plant, not as a steam factory that should be operated at a profit, but as a confounded nuisance.

I know of a factory that requires vast quantities of steam for process work. The mill is full of electric motors and the current all comes from the local central station. The monthly electric bill is nearly $12,000. This factory could produce all of the electricity it requires at practically no cost, because it could use the exhaust from the engines required to drive its dynamos. There is, roughly speaking, three-fourths as much heat in exhaust steam as in live steam.

While the main place to effect a reduction in fuel consumption, or in the cost of light, heat and power, is in the boiler room where the fuel is burned, it is not the only place.

A Chicago factory has been much concerned for some time about the high cost of its power. It has been tearing out furnaces and stokers and installing others of a different make for several years in the hope of reducing the power cost. That is expensive business. I rode by the plant a few days ago. A huge electric sign on top of the building was making faces at the noon-day sun. Somebody is asleep at the switch in that plant and, I have no doubt, he overlooks other things, too.

Fuel economy, as I have said, depends upon little things and many of them. The trouble is that the men on the job, from the manager in the office to the firemen at the boiler furnaces, are often too close to the job to see the little things that unite to make a huge total.

A factory in the east has just closed its year with what the superintendent calls "a whale of a coal bill." I found him in the act of dividing his coal tonnage into the factory output and comparing the quotient with the one he obtained last year by the same process. The fuel consumption per unit of his product was double that of 1915.

It proved to be a case of failing to watch the "numerous little things." For example, the blowoff pipes of his boilers were leaking enough hot water to account for a ton of coal a day. He had been wasting, in all, about 40 tons a day—and there were about 39 other reasons for the waste besides the one mentioned.

The way to stop the wastes in the power plant is to arouse such a desire for fuel economy that there will be no rest until all of the little causes of waste have been cataloged and the remedies devised.

SAVED 40 PER CENT OF COAL CONSUMPTION

A LETTER from the manager of a small plant in Michigan lies before me. The letter states that a saving of more than 40 per cent has been made in the coal consumption of the plant.

This plant produces a valuable by-product that enjoyed tariff protection for years. In 1913, the tariff was modified and the plant was due for a loss of about $20,000 a year. The manager felt that a saving must be made somewhere and, by accident, he thought of his coal bill. The result of his investigations was a saving of 40 per cent, effected almost immediately; and the plant will continue upon an efficient basis as long as that man is manager.

Perhaps you are about to construct a new power plant. It is very important that you should select the

*From an Article in System.

equipment best suited to your needs. Be sure that the boilers and furnaces are not mismates and misfits. Be sure that they are adapted to the fuel you ought to use; which, other things being equal, will be the fuel that can reach you with the least freight charge.

You must consider certain things with respect to fuel that you have probably never heard about before. For example, you must know about the coking characteristics of the coal if you are to burn the fuel stokers. You must not forget to learn the fusing temperature of the ash carried by the coal if you wish to keep the furnace repair bills down to the minimum. You must know how to keep your boiler plant in condition to produce the highest efficiency and you must take steps to see that it is kept in that condition. The methods of operating your plant should be standardized and you should take steps to see that these standard methods are applied effectively and continuously.

The Chief's Cold With a Grain of Salt

By the Chief Himself

IT'S the time of year when colds come like the tax collector—unexpected like; though you know mighty well they're coming.

Well, mine came, and the gang started to recommend things—from salt pork well seasoned with pepper and tied on with your wife's stocking, to a whiskey gargle. And this is bone dry territory, so that was a useless thought anyway.

I tried some several, but didn't see any conspicuous decrease in the efficiency of that cold which was still running at full rated horsepower or kilowatts or whatever a cold is rated at.

Then in came a repair man and cheerfully remarked: "Got a cold?"

"No," says I, "I'm practicing to get perfect in sneezing and blowing."

"Why for?" says he.

"Well, it makes the baby laugh."

"Now, I tell you," he remarked, quite confidential like, "I've been having colds for 26 yr., and all I use is kerosene for a gargle. It cures every time, and I got so used to it I rather like it." Imagine a man acquiring a taste like that!

But I felt so mean when I got home that I didn't care what Rockefeller thought of how I used his oil, nor much what the oil did to me, so I went down cellar, mixed a coal oil highball and started to gargle.

Somehow I lost my vacuum, or the check valve got stuck, for anyway I took most of it straight down, and the rest was a total loss. My but I felt like a mess, and smelled like Whiting, Ind.

When I came up, wife wanted to know: "Did you spill kerosene down stairs?" And I answered, "No, I don't think a single drop escaped."

One thing, I forgot the cold in tasting that oil. I didn't dare go near the gas for fear I'd explode, and the papers would say another case of "low water," while I knew it was oil in the boiler. And I didn't dare smoke to kill the taste for fear the smoke and oil gas would form an explosive mixture and spoil my appetite for supper.

Then wife said supper was ready—and I tried the corned beef and ate kerosene; I drank some coffee—and kerosene. The bread tasted like a label off an oil barrel and the doughnuts like the bunghole. And the pie, my favorite apple pie, was a forlorn reminder of Polarine cup grease.

Wife saw my predicament and suggested trying some ice cream. "They say that will kill the taste of kerosene." So one of the boys rushed over to the nearest druggery and brought home a quart.

I got rid of the oil taste all right, but I caught more cold.

Next morning I spied a quiet little carpenter who was building some falsework around the engine base ready for grouting. He hadn't said a word about my cold or offered a suggestion. So I thought he might be keeping something back. I asked him what was good for colds. And every word he said was: "Gargle with salt and water," and went on with his work.

When I got home that night, Mrs. began to remark about colds and kerosene, but I marched straight to the salt jar, put a tablespoonful in a glass of water and gargled. Swallowed some, too, but who cares? And doused it up my nose.

Say, tonight, for the first time in two weeks, I can breathe with my mouth shut. I haven't any tonsils. Don't know I have a tongue in my throat, and my lungs are working like a big air compressor.

Salt water may not be good for a steam boiler, any more than kerosene; and kerosene is sure no good for my stopped up tubes.

But—salt. That's the dope for mine. Try it, and you'll never use any other.

The Council of National Defense, with its advisory Board, has been delayed in completing its organization by lack of funds due to failure of the last Congress to pass regular appropriation bills. Nevertheless the Council has already secured the low prices for copper and steel for government use that have been announced through the daily press, an agreement by heads of labor and manufacturing associations for a truce in labor questions during the war, formation of a General Munitions Board headed by Frank A. Scott of Cleveland, vice-president of Warner & Swasey Co., and unification of operation of the entire railway system under direction of a committee of five leading railway executives.

At present, the most urgent need, as stated by President Wilson in his recent proclamation, is increased food production. Everybody should urge that all possible means be employed to utilize land and labor to the full; that farmers be encouraged and aided to plant a large acreage and assisted with supplies of capital, labor, seed and fertilizers where necessary; and that plans be made for utilizing the time of boys and men during vacation periods, and of men whose time is not employed in any vital industry.

Technical and business journals to the number of 277 have offered the use of their pages to the United States Government to support and advocate such activities as are desired in connection with the war, and will keep their readers informed as to the progress in industrial mobilization.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Starting Currents of Direct-Current Motors

DETERMINATION OF "MOTOR-TORQUE CONSTANT" EMPLOYED IN THEORETICAL CALCULATIONS. BY J. M. WALSH

IN THE selection of a direct-current motor, the exact determination of the value of the starting current is of much importance. While the actual running current, after the machinery has been brought up to speed, may be within the current-carrying capacity of the motor, the current at starting might prove to be beyond the maximum permissible overload current of that motor. In addition to its effect on the motor, the value of the maximum starting current is a necessary quantity in the proper selection of the wiring, switches and fuses used in connection with the motor.

It is common practice to assume that the probable value of the starting current will be anywhere from 30 to 50 per cent in excess of the running current. In quite a large percentage of installations, however, this assumed value is either too high or too low. If too high, the motor operates satisfactorily, but the owner stands for an excess investment in wiring, fuses and switches; if too low, the motor heats, fuses blow, and a generally disagreeable state of affairs exists for the user and the contractor. And yet, contractors, central station salesmen, and engineers, are in a position to obtain certain data, the use of which will make unnecessary any but slight assumptions as to the probable value of the starting current of a motor on any proposed installation.

The maximum current at starting is due, of course, to the fact that the turning moment, or torque, required to be exerted upon a given piece of machinery is greatest at the moment of starting. The torque of an electric motor being directly proportional to the armature current, the number of armature conductors, and the field flux of the motor, it is evident that, knowing certain definite physical constants of any motor, we can derive a very useful factor. This latter quantity may be called "the motor-torque constant."

If T = the torque in pounds at 1 ft. radius with which the field of the motor acts upon the armature while the latter is revolving at N revolutions per second, the mechanical power developed will be:

$$P = \frac{2 \times 3.1416 \times 453.6 \times 980.6 \times 30.48}{10^7} NT \text{ watts.}$$

or, $P = 8.52\ NT$ watts.....(1)

in which equations the various constants are factors of reduction from C.G.S. units to units of the English system.

According to Leng's Law, this mechanical power is equal to the product of the armature current and the counter electromotive force of the motor, because this product represents the rate at which work is done in forcing the armature current through the armature against the counter electromotive force of the motor. Therefore, if I_a is the armature current, and $\frac{F Z p N}{10^8 p^1}$ is the counter electromotive force of the motor,

$$P = 8.52\ NT = I_a \times \frac{F Z p N}{10^8 p^1}$$

from which,

$$T = \frac{0.117\ F Z p I_a}{10^8 p^1} \text{ lb. at 1 ft. radius.....(2)}$$

in which, I_a = the total current in the armature;
F = the magnetic flux in C.G.S. lines, which enters the armature from one pole of the motor field;
Z = the total number of conductors on the armature;
p = the number of field poles;
and p^1 = the number of current paths in parallel through the armature.

By substituting in (2) for I_a a value of 1 amp., we have:

$$T = \frac{0.117\ F Z p}{10^8 p^1} \text{ lb. at 1 ft. radius per ampere of armature current.....(3)}$$

as the "motor-torque constant" for any particular motor when the four simple physical constants involved have been substituted, for that particular motor, in the above equation. When these factors have been obtained from the motor manufacturers, and the value of the starting torque required by a particular piece of apparatus has been ascertained, it is a simple matter to determine quite accurately the amount of starting current which will be required under the given conditions.

For example; if a certain piece of machinery requires a torque of 200 lb at 1 ft. radius to start, and the proposed motor has a "motor-torque constant" of 2.00 lb. at 1 ft. radius per ampere of armature current, the required starting current will be but slightly in excess of 200 divided by 2.00, or 100 amp. This excess is due to the fact that the torque from formula (2) is the total electromagnetic torque developed in the motor. Of this total torque, a certain part is required to overcome hysteresis, eddy currents, friction, and windage. The other part is available at the shaft of the motor. It is obvious, though, that the amount of this lost torque is small—so small that the error caused by assuming, in the

above example, that the starting current would be actually 100 amp. is practically negligible.

The use of this "motor-torque constant" in the selection of motors for certain duties, reveals a wide variation both above and below the value of 50 per cent excess current which would ordinarily be assumed as the starting current of the motor. In fact, many motors whose horsepower ratings are amply sufficient to handle a certain given load, are found to be taxed considerably beyond their safe maximum current-carrying capacity by starting the load. The value of this constant, also, when once ascertained for a particular motor, gives a very accurate indication of the service for which it is best suited. On the higher speed motors it is, of course, necessarily small; while on the slower speed, and the variable speed motors it attains values which make this latter type of motors very desirable for many classes of work.

High Head Electric Power Plant in Brazil

SPEED GOVERNING OF HYDRAULIC TURBINES UNDER A HEAD OF 2070 FT. EFFECTED BY SWINGING BASCULE. BY FRANK C. PERKINS

AT THE hydro-electric power plant of the Compania Docas de Santos on the Jtatinga River, the head for the turbines is 2070 ft. There are 5 turbines of 4025 hp. normal and 5000 hp. maximum output, each operating at 514 r. p. m. with an efficiency of 80 per cent, of the Voith type, designed and constructed at Heidenheim, Brenz, Germany. There are 3 turbines for driving the exciters of 210 hp. each, having speed of 750 r. p. m.

It may be stated that all of the turbines are of the high-pressure impulse type, with one runner and one nozzle. The governors are provided with oil pressure pumps. The admission gate valves, the discharge valves of the pipelines and the iron guard plates in the tailrace were also installed by J. M. Voith.

The main turbine noted in Fig. 3 has a nozzle with swinging bascule with all moving parts outside the water and free for access and lubrication. By the swinging bascule the spouting area of the nozzle and the thickness of the effective jet are regulated. The swinging bascule is adjusted by means of a hand wheel to the maximum flow of water or the expected peak load.

It will be seen that the body of the nozzle is not rigidly fixed to the admission valve, but linked in such a way as to allow of swinging the whole nozzle in a vertical plane. The joint of the link has 9 in. internal

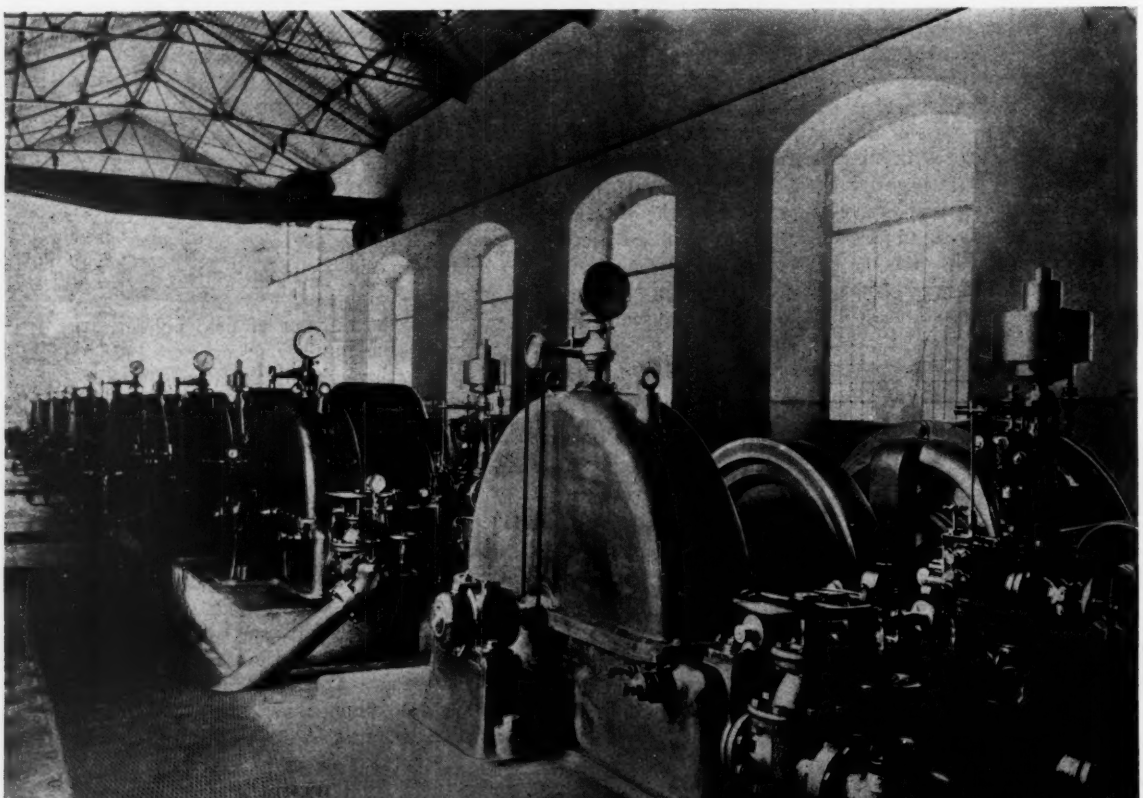


FIG. 1. SANTOS HYDRO-ELECTRIC PLANT IN BRAZIL

diameter and is made in the shape of ball and socket. The automatic speed regulation of the wheel is performed by the servometer of a most sensitive governor, which at decrease of load lowers the nozzle, so that only part or nothing of the water jet hits the buckets of the wheel, the remainder of the water going unused to the tailrace. At increase of load the nozzle is again raised by the governor, to bring a greater part or the whole part of water jet into action on the buckets.

It is claimed that this method of regulation entirely avoids any water hammer in the pipe line from suddenly shutting down the wheels. The overhanging weight of the nozzle body is counterbalanced by a hydraulic piston. The nozzles are made of cast steel and phosphor bronze.

It will be noted that the governors are of the common hydraulic type, working with oil pressure created in a rotary pump. The admission valves are of cast steel and bronze, have a clear diameter of 10 in. and are equipped with a bypass valve. The steel shaft of the turbine has a diameter of about 10 in. at the seat of the runner, 9 in. in the main bearing and 7 in. in the thrust bearing, all bearings being water cooled. It is of interest to note that where the shafts project through the side walls of the cast-iron wheel casing, a spattering box prevents leakage of water along the shaft.

The runner of the main turbine has a diameter of 6 ft. 9 in., with disk of forged mild steel and buckets of cast steel, bolted securely to the disk; the width of the buckets is more than 1 ft.

The interior view of the power house, Fig. 1, shows 5 main turbines and 2 exciter turbines. All the valves of the distributing pipes are located in a room adjoining. The head channel is divided into basins large enough to settle the sand, each having an overflow for the surplus of water and communication by means of 2 sluice gates to the forebay proper, while sluice gates control 5 pipe lines.

The main pipes and valves in the distributing room, all hydraulically operated, have a clear diameter of 2 ft. The pipe line for the exciter turbines has a clear diameter of 8 in. and is connected to each of the main pipes.

Regarding the advantages of impulse turbines for high heads, it may be stated that with high falls and comparatively small quantities of water, reaction wheels or so-called Francis turbines in most cases would give too high a pressure and turbines with free jets are more suitable.

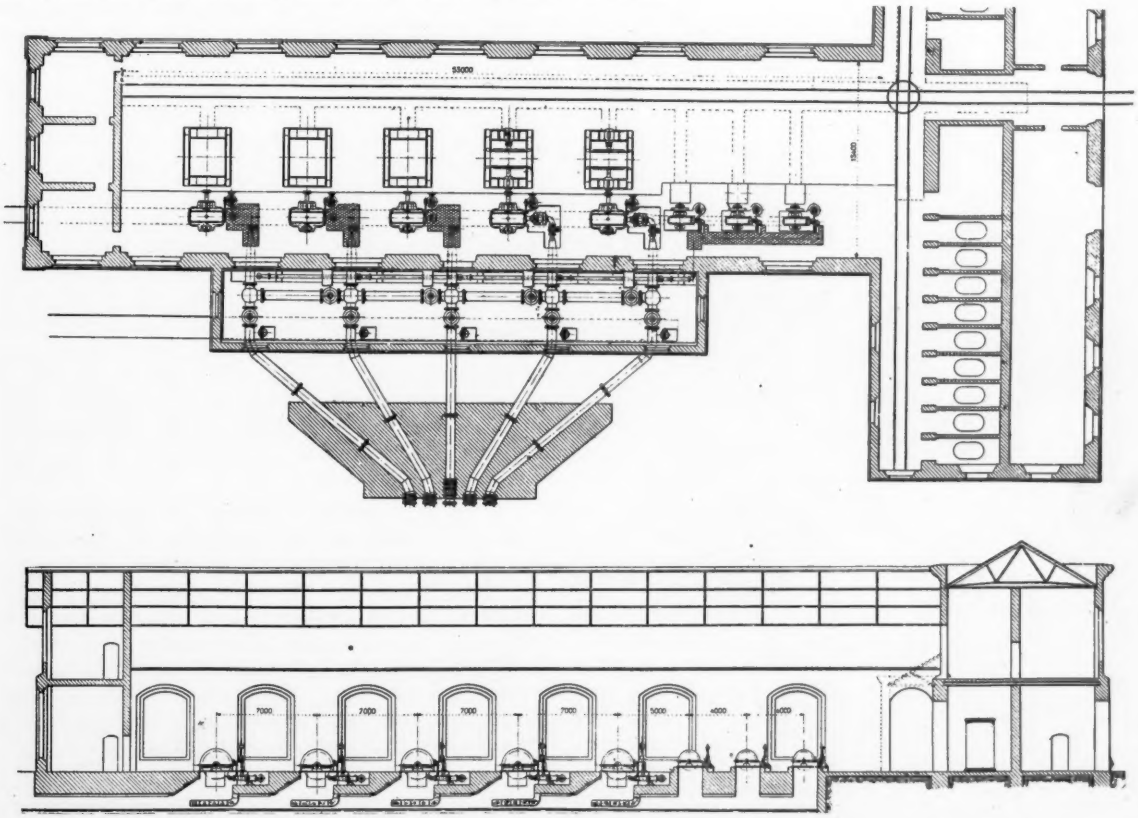


FIG. 2. PLAN AND VERTICAL SECTION OF HIGH HEAD PLANT

Formerly, turbines for such conditions were almost exclusively built after the Girard type, which in some particular instances are used even today; but the impulse turbine is usually preferred because, when properly designed, it considerably excels the Girard turbine in point of efficiency and allows of a more elegant and more accessible arrangement.

Almost all impulse or tangential wheels show the following two characteristic types of buckets either curved to a cylinder and bounded by side walls or made of ellipsoidal shape. The Voith buckets differ from both of these types. They are not made to empirical and approximate forms, but are designed from the actual path of the jet at its different parts, and this, of course, must be especially studied for each case. No particle

of the water should be discharged without having fully transmitted its energy to the bucket. This feature is realized to such a degree that, under normal conditions, efficiencies considerably exceeding 80 per cent are obtained in most cases.

It is said that, as the case may require, the buckets form with the wheel disk one solid casting or are bolted to its rim by carefully tight fitted steel bolts. The kind of material used for the buckets depends on the acting head, the size and speed of the wheel and the detritus carried by the water. Therefore, the buckets, or if found necessary the whole wheels are made of cast iron, malleable iron, mild cast steel, phosphor bronze or any other special mixture. The nozzles are made either of rectangular or circular section, the type decided upon depending mainly on the head, the quantity of water, the size of jet with reference to the dimensions and speed of the wheel. If rectangular sections are to be used, their regulation is not secured, as is usually done, by tongues moving in water and exposed to its flow and impurities; the area of the nozzle opening is changed

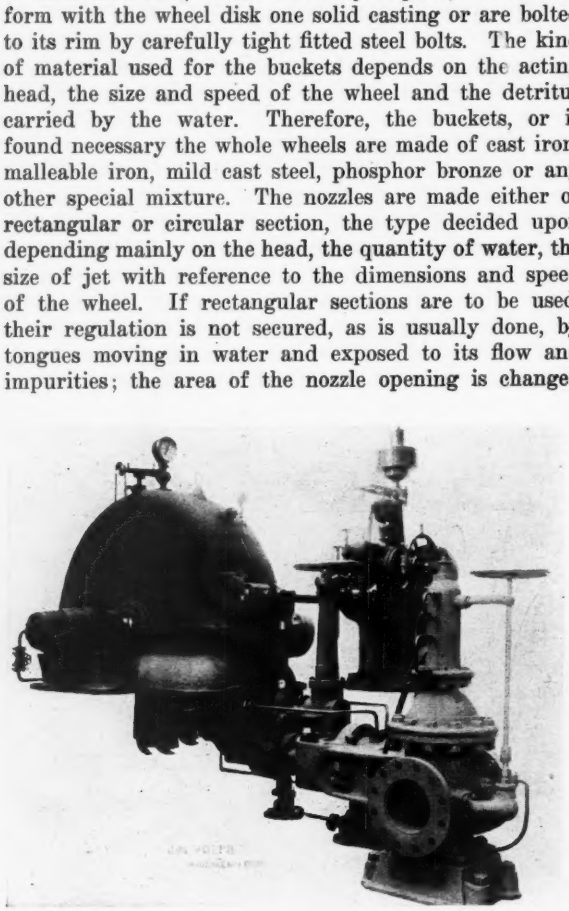


FIG. 3. VOITH TYPE TURBINE

by a swinging bascule with all moving parts outside the water free for access and lubrication.

When a circular area is chosen for the nozzle opening, the customary needle regulating nozzle is provided for. The regulating needle is perfectly balanced to offer the least possible resistance and its contour is made in strict accordance with the design ensuring the highest possible spouting velocity.

The Voith nozzle regulating devices are designed to be easily controlled, even under the highest heads, by governors with comparatively small working capacities. The spouting area of the nozzle is varied with no throttling effect, so that at all gate positions the full head remains effective and the consumption of water will be as economical as possible. For larger quantities of water or to get higher speeds, the Voith design allows even a single runner wheel to be fed from 2 or 3 nozzles arranged in such a way that no water jet is interfering with any other.

When the flow of water varies between wide limits, arrangements are made to shut down the nozzles separately by means of stop valves, thus securing best efficiency even at very small load.

In the construction of these German turbines, the parts of the nozzles subject to be worn out by sand are made of phosphor bronze and in case of repair, therefore, not the whole nozzle, but only its foremost part has to be replaced, thus considerably reducing the expense of maintenance.

It is pointed out that all movable parts such as bolts and links are placed so as not to come into contact with the water and they may be lubricated during the working of the turbine. These parts are, therefore, not liable to corrosion and will last a long time. If a uniform discharge of the water is desirable, the impulse turbine can be equipped with two regulating devices, one of them to be adjusted by hand to correspond to the available flow of water or to the peak load expected for that period, while the other, under the control of the speed governor, is directing only such part of the jet upon the buckets as is needed for the load for the time being. The balance is discharged below the buckets into the tail race.

With this system of regulation a comparatively high velocity of water in the pipe line may be used since water hammer never can occur. In addition only a small flywheel effect for regulation will be required.

It is maintained that the application of this double regulating device is limited to power plants taking their water not from any storage reservoir but directly from the river: for, in the latter case, it does not matter whether the surplus of water be wasted over the weir or through the pipes. If, on the other hand, a storing up of surplus water is intended, the arrangement of a stationary nozzle in connection with a pressure relief valve is to be employed.

It will be noted that the impulse turbines are enclosed by housings made of cast iron. The shaft projects through a frictionless shield box which prevents any spattering water from leaking along the shaft. The accessories of the turbine, as speed governors and pressure relief valves, are never attached to the turbine. It is claimed to be most important to have these apparatus erected independently. This enables a dismantling of the turbine, without disturbing such sensitive devices as are embodied in governors and relief valves.

Most perfect speed control is required in many cases such as the operation of electric stations, spinning mills, weaving sheds, rolling mills and other like factories. In many hundreds of installations erected during the past few years, modern turbines and governors have fulfilled the severest requirements under the most difficult circumstances and their steady working cannot be excelled even by the best regulated steam engines. J. M. Voith developed a speed governor working by oil pressure to such perfection that it has been employed to special advantage for governing turbines at all heads.

When it is a question of making just the best use of the water power, as for instance in wood pulp mills or when another motor constantly co-operates with the turbine and regulates the speed, a water level governor may serve very well this purpose in maintaining a uniform head level and the highest possible fall, so that even with fluctuating flow of water the total available water power will be always completely utilized.

Low Power Factor Causes Trouble

By A. C. McHugh

INSULATION of the field coils of several a.c. generators was found to be partially broken down, and it soon became impossible to carry more than half their normal load with the exciting capacity available.

The manufacturer's representative declared the trouble was due to the low power factor of the system (about 65 per cent); but the engineer argued that even though the power factor was low, the current registered by the ammeters rarely attained the rating of the machines (56.8 amp.), and it necessarily followed that should the power factor have been unity with like ammeter readings, the exciting current would have been the same, and the only effect that the low power factor could possibly have, would be to decrease the kilowatt-hour output. Therefore, he believed the manufacturer to be responsible for not having insulated the field coils properly to withstand the exciting current necessary to develop the generator rating.

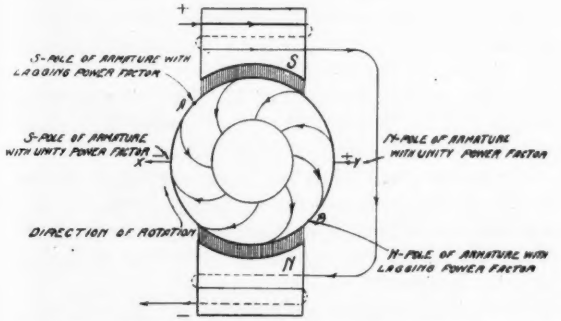


DIAGRAM OF GENERATOR FIELD SHOWING EFFECT OF LOW POWER FACTOR

In answer to the engineer, the representative drew a sketch of a 2-pole single-phase alternator.

"Now," he said, "when the armature field is at the point x-y, the electromotive force in the armature winding will be at a maximum. If the power factor is unity, the armature current will also be at a maximum, i.e., in phase with the electromotive force; and the field set up by this current will be so far removed from the main field coils as to have little or no effect on them; but should the power factor be reduced, and the armature current lag behind the armature electromotive force, it will not have attained its maximum value until the electromotive force has begun to decrease. This will cause the fields set up by the armature current to occupy a position nearer the main field coils (points A and B) and, as the polarity of the main fields and that of the lagging armature fields will be the same, the flux set up by the armature current will oppose the main field flux, thus weakening it and necessitating an increase in exciting current in order that the proper voltage may be maintained. Now, it is easily seen that the lower the power factor drops, the greater will be the opposition to the main flux due to the armature poles coming nearer the main poles. And in your case, although the machines rarely carried the full rating in amperes, it is evident that the field current necessary to produce the normal load (¾) must have been considerable, with a power factor of 65 per cent."

The engineer saw the point and admitted that the representative had shown him something he did not know.

In repairing the field coils, more turns were used and no further trouble was experienced.

Humidity and Volumetric Efficiency

I HAVE read with careful consideration the article in the Mar. 15 issue of Practical Engineer, by Frank Richards, on Intercooler Efficiencies, in which he says it will not increase the volumetric efficiency, or reduce the horsepower required to operate an air compressor, to remove the moisture or water from the air passing through the intercooler.

I beg to take exception to his view and give one experience I had along this line, while I was employed as superintendent of a large manufacturing plant in the West, a position I held for over 30 yr.

In 1912, our firm secured a contract to build about 8 mi. of 24 and 30-in. steel riveted pipe, No. 5 steel, to stand a working pressure of 125 lb. per square inch. We were under contract to deliver 400 ft. per day. We had an 850-cu. ft. 2-stage air compressor of a well known make equipped with the Standard intercooler.

When we started work on our pipe line, we were running the compressor at its catalog speed of 160 r.p.m. using a 150-hp. General Electric motor. Our voltage was high, but our motor ran hot, and showed plainly that we were using all its power. We broke 2 cylinder heads on the low-pressure side and it was all we could do to keep the compressor in running order, and we could get air enough even at 80 lb. pressure to operate but little over ½ of the equipment required to make the 400 ft. of pipe per day.

I tried forcing more water through the intercooler; this helped matters as far as cooling the air to a lower temperature was concerned, but did not give us enough air or help us keep up the pressure we wanted. We were just about to do what many others have done when they found they were short of air, that is, buy another compressor, when the writer decided to build an intercooler, with the view of removing the water from the air before it reached the high-pressure cylinder.

We never got any water from the old intercooler; but when we got the new one in operation there was a constant stream of water running from it and our air troubles were over. We could carry 100 lb. pressure, had air enough to operate our entire equipment even after we reduced the speed of the compressor from 160 r.p.m. to 130 r.p.m., removed the 150-hp. motor and put in an old type 75-hp. L frame General Electric motor which our tests showed was developing about 85 hp.

We were about 5 mo. on this pipe line and never stopped one minute through the day on account of air or compressor troubles.

In view of the above facts, I am forced to the conclusion that an intercooler to be efficient must not only cool the air but remove the water from the air before

it enters the high-pressure cylinder of the compressor. Now, if, as Mr. Richards says, the removal of 75 per cent of the water will only increase the volumetric efficiency of the compressor, ½ of 1 per cent and only reduce the power required to operate the compressor 1 per cent, I would like to have him or some other compressed air expert tell me how I got the results we got at the Union Iron Works by simply removing the water.

H. E. MacCamy.

I WAS VERY glad to receive a copy of Mr. MacCamy's interesting letter and to be given an opportunity immediately to reply.

I refrain from discussing Mr. MacCamy's narrative of the installation of his intercooler, for I do not believe the results accomplished can be attributed to the intercooler. I do not question the truth of the story. In fact, as it stands, it tells too much truth, although there is absence of precise data which could be subjected to computation or comparison. We do know in a general way that there was a compressor installation running under bad conditions, and consequently inadequate for the service required of it. The electric motor was so bad that it had to be thrown out entirely. What other reason could there have been for throwing it out? Of course, a smaller motor that would work must have been better than a larger one that would not work.

Besides the motor, the air compressor itself was in such a bad condition, he tells us, that in running it, 2 cylinder heads had been knocked out. After the defective motor had been replaced and the compressor overhauled with the addition of a new intercooler things worked much better than before.

As to the effect of any intercooler, however perfect, upon the volumetric efficiency of a 2-stage compressor, I have not much to say, and I am very content to leave that to common sense. In talking of the matter, I would use the word "capacity" instead of "efficiency." The full stroke of the piston of the low-pressure cylinder is followed by an inrush of air behind it which fills the entire space, and then the inlet valves close. If, upon the return stroke, all of this air could be expelled into the passage leading to the intercooler and then the discharge valves closed, that volume multiplied by the number of strokes per minute would be the capacity of the compressor for the same unit of time.

We all know that some of this air is not expelled or delivered, being retained in the unavoidable clearance spaces and re-expanding upon the return stroke of the piston; also, there usually are more or less piston leakage and valve leakage, so that the actual volume of air delivered is a more or less uncertain quantity; but whatever this quantity may be which passes the discharge valves and so on through the intercooler must, barring leakages, go on through the machine and be delivered into the compressed air system. An intercooler does not create air and does not destroy air, and cannot have a retroactive effect upon anything that goes on in the low-pressure cylinder.

The normal function of the intercooler is to reduce the temperature of the partially compressed air delivered by the low-pressure cylinder, and consequently its volume, so that the power required for the second stage of the compression will also be somewhat reduced, but the most valuable effect of the intermediate reduction of temperature is the prevention of excessively high temperature at the completion of the final compression. As Mr. MacCamy concedes that the old intercooler in his narrative could be made to cool the air with tolerable respectability, it is not worth while to go into that matter here. Air apparatus has been improved rapidly, and the intercoolers of all the builders may be expected to be more efficient than was that one of an earlier date.

The function of the intercooler in reducing the temperature of the air affords incidentally an opportunity for removing some—not all, by any means—of the moisture carried by the air.

To begin with, it is necessary to call attention to some incontrovertible facts. Air always carries water in the form of invisible vapor, and is always picking up water, or, as we say, absorbing moisture, when in contact with water or wet things. This it does up to a certain point when it promptly ceases to take any more, and then it is said to be saturated or to have a humidity of 100 per cent. This saturation point varies constantly with every slight change of pressure or of temperature. As the pressure of the air increases or, what is the same thing, its volume decreases, its capacity for moisture decreases in about the same proportion; but whatever the pressure or relative volume, an increase of temperature increases the water carrying capacity of the air very rapidly. For each rise of temperature of 20 deg. F. the moisture capacity of air is doubled, and, of course, it is similarly reduced by similar fall of temperature.

Only one other thing is it necessary for us to remember as we go along. If the humidity of the air be anywhere below 100 per cent, it will not give up the moisture it carries, or will not wet things by contact so that water may be drawn off.

Immediately, however, that the 100 per cent limit is passed, say by the cooling of the air, all the water in excess of the 100 per cent is ready to be given up at once, which gives the mechanical separator its opportunity.

We may suppose an air compressor to be in full operation with the air entering the low-pressure cylinder with a humidity of 60 per cent at a temperature of 60 deg. F. and being compressed and passed on to the intercooler at a pressure of 25 lb. gage. The volume of the air, under adiabatic compression, will be almost exactly ½ and the relative humidity we might say had thus been raised to about 120 per cent; but, at the same time, the temperature of the air has been raised from 60 deg. to considerably above 200 deg., or the moisture capacity of the air has been increased 7 or 8 times, and its percentage of humidity, with all the original moisture still in the air, becomes less than 10 per cent, very dry air indeed, as it enters the intercooler.

It is all very well for the intercooler to be posing before the public as a highly efficient water separator, and I am not refusing to believe what it may actually be doing in that line, nor am I by any means belittling the desirability of getting as much water as possible out of the air at this stage; but I would like to call attention to the lively work which the intercooler has to do. It will appear that the whole intercooler cannot by any means be made to act as a water separator, but only a little of the latter portion of it, because the air has to be

cooled from above 200 deg. to below 100 deg. before it will begin to give up its water at all.

We thus see the importance, if any water separating is to be done at this stage, of having the intercooling as efficient as possible, since it is only the last few degrees of the cooling that brings the air to the supersaturation point. A much better arrangement, in any case, would seem to be to have an intercooler doing only the intercooling, and then to pass the air through an efficient separator as a distinct unit and taking the air necessarily at its lowest temperature.

The air, after passing the best possible intercooler and separator and then being compressed to its final pressure in the high-pressure cylinder, will be discharged from the latter, the same as from the low-pressure cylinder, in the condition of extremely dry air, on account of its high temperature; but with an aftercooler and another separator, or with a pipe line of sufficient length to give the air a chance to get entirely cool again, the water will again be in evidence. It is only when the air is at its highest pressure and its lowest temperature that it can be so drained of water as to cause no possible subsequent trouble, and neither of these conditions can occur in any intercooler. FRANK RICHARDS.

Making American Citizens

BY J. P. RAWLEY

AT the end of the civil war the slaves of the South took the names of their former masters, and started life under miserable circumstances. As they had not been trained to think for themselves, they gravitated from bad to worse, half starved, ragged, shoeless, living in log cabins that did not protect them from the rain and storms, which conditions brought about pneumonia and consumption. Their children came into the world emaciated, their little bodies dwarfed and weak, their minds feeble, which gave them a pitiable start upon life's journey, if they could cling to life at all.

The object of this article is not to give a picture of the privations and sufferings of the past, but to tell our readers of the bright side of the story.

Eight white men of Winston-Salem, North Carolina, saw these deplorable conditions among the children of their former slaves who now bear their names, and combined to uplift them, and think for them and manage for them. This was glad news for the colored people, who thankfully embraced every aid offered them and their children.

A school was started under the name of The Slater Industrial Colored School at Winston-Salem, North Carolina, with Wm. A. Blair, of the Peoples National Bank, as treasurer. He has been treasurer all these years, and it does not overstate facts to say it is the best managed colored school in the entire South and ranks fourth in importance.

The school is maintained by the State, Town, County, Rockefeller General Educational Board, and The Slater Fund, after which it was named. It has wiped out all race friction and solved the race problem absolutely. More colored people own their homes in this town than in any town in America of the same size. Not a colored man in jail; it is truly a mecca for them, and the two races live in harmony.

The school buildings, land and appliances have cost $80,000. So great is its influence that the State Legislature has offered the trustees $12,000 if they will raise an equal amount to enlarge the plant. It is impossible for them to meet this offer at home, as they have strained themselves to the extreme limit to build it up to its present worth.

If each reader of this article will send Treasurer Wm. A. Blair one dollar, and no more, the trustees can meet the offer made by the State. Thus with $24,000 for material, the plant can be enlarged by $48,000, as the friends of the school will give the labor free, which will equal the value of the material. So it is plain to see that each dollar sent the school now will multiply four times when it becomes bricks and mortar.

Let it be remembered that the colored citizens are loyal citizens. Not one of them ever raised his hand against our flag; many of them are in our army and are brave soldiers, and they are answering the President's call for troops all over the South.

Send the dollar today. You won't miss it, and it will do more good for a national cause than any dollar you ever before contributed to the Nation.

Condenser Tube Corrosion

RESEARCHES by a committee of the Institute of Metals of England, in which laboratory investigations have been made at the Royal School of Mines and working tests at the Corporation Electricity Works, Brighton, have given valuable information as to causes of corrosion in condenser tubes. The work has been done under the direction of Capt. G. D. Bengough, and results are reported in Engineering, of London.

Corrosion may be started by defects in the tube caused by manufacturing processes. In brass tubes, a "spill," which originates in a blow-hole against the sand core of the casting from which the tube is made, becomes a long groove covered with a sliver of metal. Air collects in the space thus formed, and in sea water results in corrosion. An open groove, not covered by a "spill" appears to have little effect. A pit produced by a bit of grit remaining on the surface of the blank after boring and before drawing matters little in causing corrosion.

Alloys have been tested including a 2 per cent lead in which the salt from the lead seems to form a protective covering. Also a 10 per cent nickel and 90 per cent copper which laboratory tests so far have shown to be immune, even when the tube surfaces are quite rough, and collect air bubbles. Such bubbles collecting on brass form a white oxychloride zinc which takes up chlorine from the sea water and passes it to the zinc, thus removing the zinc from the brass.

On the other hand, 20 per cent nickel and 2 per cent nickel alloys have shown failures, so that the 10 per cent alloy seems to have peculiar action.

An alloy of copper with 7.8 per cent aluminum shows promising results if freed from oxygen. Where oxygen is present, small pinholes appear and rapidly deepen, the rest of the metal showing no corrosion.

Further experiments are now under way with oxide-free brass and with tubes annealed at 452 deg. F. (400 deg C.), and at 1112 deg F. (600 deg. C.), after drawing and before testing. Results will be furnished as the tests are completed.

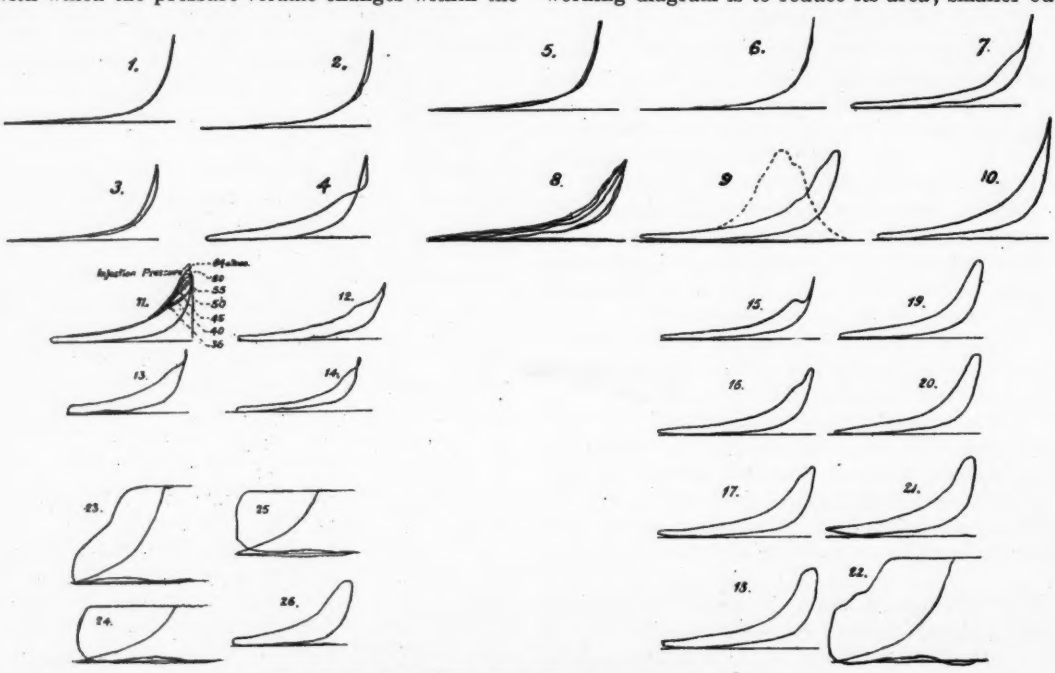
GAS POWER APPARATUS

Producers, Engines and Industrial Applications

How to Interpret Indicator Cards from Diesel Engines

NOTES ON THE EFFECTS PRODUCED IN DIESEL INDICATOR CARDS BY VARIOUS CONDITIONS AND OCCURRENCES. BY R. E. NEALE

INDICATOR cards alone make possible study of the occurrences in an engine cylinder. In the light of practical experience these diagrams indicate at once defects or errors in valve gear and valve setting, etc., so that the performance of the engine concerned can often be greatly improved by adjustments, simple in themselves, but the necessity for which it is difficult or impossible to detect by any other means. The value of any indicator card naturally depends essentially on the accuracy with which the pressure-volume changes within the engine cylinder are recorded. High accuracy is now attainable and is taken for granted in the following notes, which refer to the interpretation of Diesel engine cards.



EXAMPLES OF DIESEL ENGINE INDICATOR DIAGRAMS

To investigate compression conditions in a Diesel engine, indicator cards are taken while the fuel valve is closed, the engine meanwhile being driven by the kinetic energy of the flywheel. The diagram obtained is made up of suction, compression, expansion, and exhaust sections, and should have the form shown in diagram 1. The maximum compression is 33 atmospheres (500 lb. per square inch), and on its magnitude the correctness of the diagram form depends very largely. Theoretically, expansion and compression curves should coincide (as in diagram 1); but this is never the case in practice, the compression line running below the expansion line, due to leakage and withdrawal of heat. If leakage be great, for any reason, diagrams are as in 2 and 3, and the effect of leakage on the normal working diagram is to reduce its area; smaller output is obtained, and the fuel consumption is comparatively high. In 4 is reproduced a diagram showing considerable leakage, but whether the leakage is past piston or valves cannot be determined directly from the diagram.

In diagram 5 the lower part of the compression curve deviates from the expansion line, but the tracing of the latter below the compression curve can only be attributed to indicator error. Diagrams 6 and 7 refer to abnormally high compression (550 lb. per square inch). In such cases the diagram runs usually up to

a point. Only increased advance of ignition and corresponding injection pressure can produce partial flattening of the diagram.

Compression curves should be taken after the engine has warmed up, otherwise they will be steeper than normal and attain a lower maximum pressure.

The factors influencing combustion phenomena in internal combustion engines are as yet imperfectly understood. Every engine has its own peculiarities, which can only be determined by careful investigation.

To ensure complete combustion the fuel pump must be intact. In 8 is reproduced a series of diagrams showing leaky fuel valves, due to which the quantity of fuel fluctuated violently. Similar conditions often arise during light running of Diesel engines. The governor loses control and both torque and speed are unsteady.

Theoretically, combustion takes place at constant pressure in Diesel engines, but this condition is seldom realized even approximately. Diagram 9 refers to an engine running at 260 r.p.m. The dotted curve, drawn to a larger scale, shows that combustion produces pressure rise after the end of compression, part of the charge burning at constant volume and part at constant pressure (approximately). The relative amounts of fuel burning under each condition depend chiefly on the compression and injection pressures, nozzle opening, revolutions per minute, and moment of ignition. If the compression be high it may happen that, with correspondingly advanced ignition and under normal load, combustion occurs at constant volume.

Another type of combustion curve—a steeply descending isothermal—is shown in diagram 10.

The effect of varying injection pressure is obvious from 11; the higher this pressure, within the limits shown, the greater the effective area of the card and the better the form of the expansion curve. Diagram 12 refers to an engine in the piston of which a hole had accidentally been bored opposite to the fuel valve. Incoming fuel collected in this hole, and by burning during the expansion stroke caused a hump in the latter. On detecting such a belated pressure rise, search should be made for crevices or pockets in which fuel can accumulate.

Pressure rise during combustion is greater the greater the advance of ignition. Simultaneously, the amount of fuel burning at constant volume increases. If the ignition advance be small, or even negative (due to incorrect adjustment), the effective area of the diagram is reduced as in 13. After reaching the compression dead center, expansion commences along the compression line (as in diagram 1); then when fuel is at last admitted the expansion curve runs nearly horizontal for a time or may even rise. The ignition advance is generally kept constant independently of load, with the result that at light loads diagrams 15 to 18, of the form shown in 13, are produced. On increasing the load the diagrams revert to their usual form. Diagram 14 represents a case in which ignition is late and leakage present.

Oscillations in the combustion line, if not due to indicator vibrations, indicate incorrect motion of the nozzle needle. If the injection pressure be abnormally small at normal load the nozzle is too large, the machine becomes foul and works irregularly. On the other hand, if the nozzle be too small a higher injection pressure is required to secure correct diagram form. High injection pressure tends to produce irregular working, since each inrush of air cleans the atomizer plates thoroughly and leaves nothing to facilitate the next ignition. The form of the cams operating the fuel valve has been subjected to numerous theoretical and practical investigations. It is a problem of great importance and one which appears to admit of a number of satisfactory solutions.

The form of the expansion curve is considerably affected by retarded combustion and leakage. Retarded combustion and late ignition are often attributable to imperfect atomization of fuel. Their occurrence is indicated by a bulging of the expansion line and high pressure at the end of the expansion stroke. Since heat is added during expansion, the expansion line lies above the adiabatic, and by drawing the latter and comparing it with the actual expansion curve, retarded combustion may be detected. The effects of leakage on compression diagrams and combustion curves have already been noted; by these effects the presence of leakage may be detected. Naturally, leakage reduces the effective work done during expansion.

The course of the exhaust line is of great importance in determining smooth and quiet working. By opening the exhaust valve before the end of the expansion curve, sudden pressure drop is avoided at the dead center. Diagram 19 shows a well-rounded exhaust line; but diagram 20 shows too early opening of the exhaust valve, a pointed "toe," and unnecessary sacrifice of useful work. In 21, on the other hand, the exhaust valve is opened too late, expansion is continued during the exhaust stroke, the diagram is again pointed, and (as in the case to which 20 refers) running is noisy.

The later portion of the exhaust line and the suction curve must be investigated on diagrams taken with a specially weak spring. Generally the exhaust line is found to be wavy (see 22). The rapid outrush of gas following opening of the exhaust valve terminates in a pressure lower than corresponds to the resistance to be overcome. Following this depression there occurs a pressure increase, then another depression, and so on to the end of the stroke. Diagram 23 shows 2 complete waves in the exhaust line, but in 24 the second wave is incomplete, and the suction stroke commences when there is a slight overpressure in the cylinder. If the natural frequency of the exhaust pipe coincides with that of the pressure oscillations, marked pipe oscillation may be set up by the resulting resonance. These remarks apply also to the suction pipe showing a pressure somewhat above instead of below atmospheric at the end of the suction stroke. The constant pressure maintained for a time at the beginning of the suction stroke in the same diagram is attributable to late closing of the exhaust valve so that exhaust gases are drawn in with the air. By opening the suction valve slightly before the upper dead center is reached, it is secured that a maximum fraction of the suction stroke is available for drawing in fresh air. An overpressure at the end of the exhaust stroke, due to pressure oscillations, involves a small expansion at the beginning of the suction stroke. Normally the suction line runs parallel to the atmospheric line, and the smaller the resistance to be overcome the greater the amount of air drawn in.—The Power User.

Diesel Engine Piston Lubrication

PURE mineral oils are best for lubrication of Diesel engines; compound oils, though good, sometimes show disintegration under repeated use, and may leave a gummy deposit. If, in the air compressor, the oil causes pitting of valves and shows acid scouring effect, the wear in the main engine cylinder is likely to be excessive, running as high as 0.01 to 0.012 in. in 1000 hr. run for a heavily loaded engine.

Oil with viscosity of 130 to 180 at 140 deg. F. works well for pistons, while viscosity of 400 to 500 at 140 deg. F. seems better for use on the small end parts.

Enclosed type engines, because of higher temperature in the crank case, require thicker oil than open type. On a number of naval engines, change from viscosity of 110 to that of 140 reduced the oil consumption from 0.45 lb to 0.419 lb. per brake hp.-hr.

Where different oils are used for pistons and small end, they should be so chosen that they will blend if mixed, and must not emulsify if any water gets into the crank case, as the oil should be separated from the water for reusing. But filtered oil should not be reused too often, as the viscosity will get too low for good lubrication of the pistons.

Where the customary method is used, of quills through the water jacket to the cylinder liner, it is well to have a 6 or 8 feed lubricator, to give separate feed to each quill. Though costly, this is a precaution against piston seizure due to defective lubrication or leaking back-pressure valves. It is well also to have the lubricating pump lower than the quill line to avoid draining that line when the engine is stopped; and sight feeds with regulating valves on each quill supply line are desirable. The check valve in the lubricating line should be set vertical so that gravity assists in closing it, and should be regularly examined to make sure that it does not become clogged so as to hold open.

The quill through the water jacket to the liner should be so held that it will not act to prevent the liner from expanding when heated, as such action has sometimes caused seizing of the piston at the points where the quills entered the liners. For pistons up to 15 in. diam. a splash system has been found effective, the piston having the lower end protruding beyond the liner at the bottom of the stroke so that oil can be splashed over it and carried up to the liner surfaces, but for larger diameters this method has been found unreliable, either wasting oil or giving insufficient supply.

Top Ends

PHOSPHOR BRONZE has proved more durable than white metal for top end bearings, the former seldom showing more than 0.0001 in. wear in a year, while the latter may show more than that in a week. For a split bush, 0.003 in. clearance is sufficient vertically and 0.006 in. at each side, and for a solid bushing 0.007 in. vertical and 0.008 in. at the sides.

In piston design, it is desirable to have the skirt or lower end of length 1.5 times the diameter for slow speed engines, and at least 1.2 times the diameter for high speeds in order to give a good guiding surface, and reduce the side thrust pressure per unit area. Also the wrist or piston pin should be carefully placed to prevent heeling over of piston at top or bottom, and the pin should be case-hardened on bearing surface and ends to give long life and avoid upsetting.

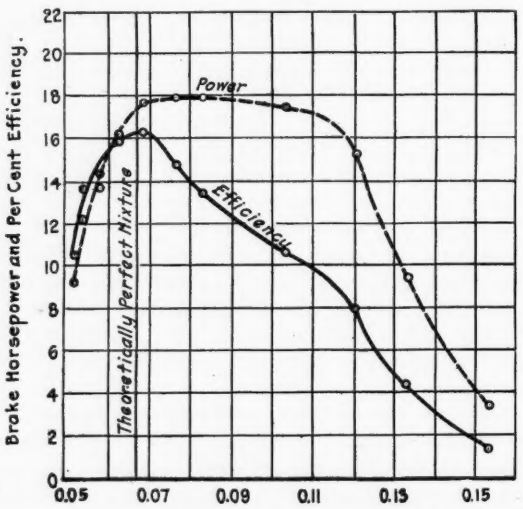
Considerable detail is given in the paper before the Diesel Engine Users' Association from which this data is abstracted in the Engineering Survey of the A.S.M.E. Journal as to the best method of slotting pistons to secure proper pin lubrication, but drawings are needed to make the method clear, and are not given in the abstract.

Carburetor Performance

Why Double the Fuel and Get No More Power?

IN a paper before the Society of Automobile Engineers, Professor R. C. Berry gives facts which are of interest in stationary as well as in automobile operation. He states that the best carburetor is one which maintains a sufficient vacuum to atomize the fuel properly and adds enough heat to gasify the mixture. The amounts of vacuum and heat needed will depend on the fuel and the methods used for atomizing and heating.

Experiments showed that the best results, both as to power and fuel economy, are obtained when the theoretical amount of air is supplied in the mixture to burn the fuel properly. The engine will run with a mixture considerably leaner than this, but does not pull well;



RELATION OF GASOLINE CONTENT IN MIXTURE TO POWER AND EFFICIENCY OF ENGINE (1300 R.P.M.)

the power increases slightly with enriching of the mixture above the theoretical proportion, but with increasing fuel consumption, up to a maximum point, after which both power and efficiency decrease, the former slowly, the latter rapidly. The range through which the engine will operate at all is from about 18 per cent below theoretical ratio of fuel to air up to 15 per cent above that value, the richest mixture having 3 times as much fuel as the leanest.

As a practical result the rule is given for adjusting a carburetor. Decrease the gasoline proportion until the engine loses power. Then increase slowly until good power is restored—and not a notch beyond.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Handling Valves

AFTER HAVING NOTED several firemen, in using valves about the boiler room, making mistakes in the manner of operating them, opening them when they intended to close them, and jamming them shut with a wrench on the wheel, I typed the following and pasted it up on the bulletin board:

Accidents are often caused by the improper operating of important valves about a steam plant; when one does not feel sure about the proper use of a steam, or any other valve, it is better to let it alone than to make a mistake that might cost a life, an injury or mayhap the wreck of a piece of machinery. Almost all valves are opened by turning the wheel to the left, and, of course, closed by turning to the right; however, there are some that are not, so always look on the hand wheel to see if there are any directions marked showing which way to turn. Plug cocks are the most troublesome. To remember the direction to turn the handle, always look for the mark on the top of the plug, and do not move it unless you are sure you are right.

In handling a valve, do not use a wrench to aid in closing except in extreme cases of stiff valve stems, and then use good judgment and do not twist the valve stem; also notify your chief about the valve that requires a wrench.

When you set up on a leak in the packing gland of a valve, set up each stud nut the same amount, and only enough to stop the blow. If it will not stop by a reasonable amount of tightening of the gland, do not strip the stud threads, or bend the gland—notify the chief.

Try to keep the threads of all valve stems clean, and thus prevent their working stiff.

Valves that are located over the boilers, or in hot places, generally get the most abuse and least care.

These notes posted in the boiler room have helped considerably in the proper use of valves. I also posted several sectional views of the different types of valves installed there, cutting them out of catalogs furnished me by the makers.

I intend to post other helpful notes each week on boiler room subjects. C. H. W.

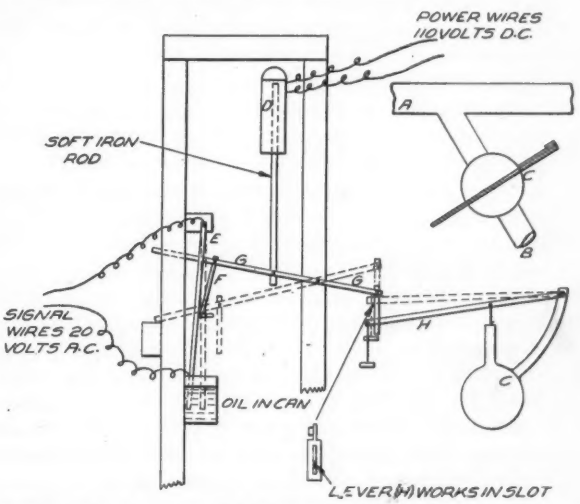
Unique Remote Valve-Control System

HEATING MAINS and light and power lines serving the 18 buildings of The State College of Washington are carried in a reinforced concrete tunnel having sectional dimensions of 5 by 6½ ft. Steam for high-pressure service is maintained at from 30 to 60 lb., depending upon weather conditions, while 5 to 10 lb. is used for low-pressure work.

Engines, pumps, etc., exhaust into the low-pressure main supplying a portion of the steam required in the line while the rest is made up from the boilers through a reducing and pressure regulating valve; the high-pressure line is supplied from the boilers through a pressure regulating valve.

The buildings farthest from the boiler plant are served by the high-pressure line; those in close proximity to the plant are served by the low-pressure line and those in between can be heated by either high or low pressure as circumstances may require.

Water of condensation returns to the hot wells by gravity and is fed to the boilers at a temperature of from 150 to 200 deg. F. This water being distilled, much trouble and expense incidental to water softening, boiler cleaning and so forth is eliminated.



SCHEMATIC DIAGRAM REMOTE VALVE-CONTROL SYSTEM AS EMPLOYED AT THE STATE COLLEGE OF WASHINGTON

Where the main is tapped for the supply to the different buildings a unique remote control device designed by Prof. H. V. Carpenter, head of the Department of Mechanical and Electrical Engineering, is employed. Referring to the accompanying sketch, A is the steam main, B the line to buildings, C the pressure regulating valve, and D a solenoid. It will be noted that in the "on" position, the pressure regulating valve is free to control the pressure to the buildings and that with the signal circuit closed through iron trigger E the signal light in the boiler room burns.

If the button in the boiler room controlling the circuit supplying current to solenoid D is now pressed, the iron plunger is drawn upward. We then release the button and as trigger E swings slowly through the oil in

the can, trigger F misses the catch on trigger E and arm GG assumes the position indicated by the dotted lines, thus holding the pressure regulating valve closed. The signal circuit being opened by trigger E swinging over to the center of the can, the signal lamp is dark and indicates the steam shut off.

To turn on the steam, the button is pressed, causing the plunger to be drawn upward and trigger F engages with the catch on trigger E, holding arm GG in the position shown. This causes trigger E again to close the signal circuit. D. F. ROUSE.

Capacity of Condenser Pumps

AN ENGINE developing 7000 i.hp. using 16 lb. steam per indicated horsepower-hour, including auxiliaries, will exhaust 112,000 lb. to condenser per hour.

Work to be done by air pump depends upon the volume of air and water to be extracted from condenser and delivered against atmospheric pressure. Any air which enters the condenser at atmospheric pressure, or 15 lb. absolute, expands in a vacuum of 26 in. to about 7 times its original volume, and this increased volume must be provided for in the displacement volume of the air pump. The air pump must handle $112{,}000 \div 60 =$ 1866 lb. of water per minute in addition to an unknown quantity of air and vapor. To allow for this, it is usual to make the capacity of air pump about 25 times the volume of water to be exhausted from condenser.

Making the displacement volume of pump $1866 \div 62.5 = 746.4$ cu. ft. per min., a simplex single-acting pump, to make 50 effective strokes per minute, must have a displacement volume of $746.4 \div 50 = 14.9$ cu. ft. per stroke = 25,747 cu. in., making the length of stroke 26 in., the pump piston, or bucket, will be $25{,}747 \div 26 =$ 990 sq. in. = 35½ in. diameter. The piston speed will be $(26 \times 2 \times 50) \div 12 = 216$ ft. per min.

Average load on air pump bucket may be taken at 10 lb. per square inch, the horsepower required to drive the pump will be $(990 \times 10 \times 26/12) \div 33{,}000 = 32.4$. not counting friction or other losses, this being the power required for effective, or up stroke of the pump only. The air pump, being single-acting and vertical, would add rather than absorb power on its down stroke due to the weight of bucket and other working parts.

Steam cylinder to drive the pump to be double-acting, allowing 30 lb. per square inch effective mean pressure on steam piston, the piston will be $(32.4 \times 33{,}000) \div (50 \times 2 \times 30 \times \frac{26}{12}) = 164.5$ sq. in. = 14½ in. in diameter, assuming that only one cylinder is to be used.

In the article, Proportioning Surface Condensers, in the Feb. 15 issue, we found 1021 cu. ft. condensing water would be required per minute to condense the exhaust from an engine developing 7000 indicated horsepower. The circulating pump must be proportioned to suit the highest temperature of water to be used for condensation. The area of suction and discharge openings should be such that the flow, or velocity, does not exceed 600 ft. per minute, of $\frac{1021}{600} = 1.7$ sq. ft. = 245 sq. in. = 17⅝ in. diameter.

The size of impeller for centrifugal circulating pumps varies considerably for different types, 3.3 times diameter of suction pipe being a fair average. $17.5 \times 3.3 =$ 57.7 in., or $1.8 \sqrt{1021} = 57.6$ in. diameter. Speed of impeller at circumference is usually 1400 to 1500 ft. per minute, or $(57.6 \times 3.1416) \div (12 \times 100) = 1516$ ft. per minute circumferential velocity at 100 r.p.m. $(\frac{57.6}{1.8})^2 =$ 1024 cu. ft. of water will be delivered by pump wheel, or impeller, per minute. Width of impeller at periphery should be $17.5 \div 4 = 4.4$ in.

Pump to be capable of elevating water 30 ft. high; $1024 \times 64 \times 30 \div 33{,}000 = 59.3$ hp. will be required.

Making an allowance of 30 per cent for water friction and loss in cylinder, $59.3 \times 1.30 = 77.0$ hp. must be developed by the engine or motor driving the circulating pump, which is to run at 100 r.p.m. Making the stroke of engine 14 in., the piston speed will be $(14 \times 2 \times 100) \div 12 = 233.3$ ft. per minute. Allowing a mean effective pressure of 60 lb. per sq. in., the steam cylinder will be $(77 \times 33{,}000) \div (60 \times 233.3) = 181.5$ sq. in. = 15⅛ in. diameter.

Ordinarily a circulating pump is not required to lift water 30 ft. only in case of pumping from the bottom of a ship overboard; therefore, a small percentage of the above power would be necessary. H. J. TEIPER.

Plant Improvements to Increase Economy

WITH COAL costing practically double what it did a year ago, manufacturers are now willing to put out money that they refused to invest previously to obtain economy. As a result, I was sent to a newly acquired plant to see what could be done to obtain better economy.

The boiler plant consisted of 6 150-hp. return tubular boilers stoker fired with forced draft and air induced draft equipment to help out the chimney, which was overloaded after putting in the last boiler.

Investigation revealed that a large open tank in the boiler room was used to receive the returns from the heating and drying systems, being returned to this tank by several steam traps. The needed make-up water was piped into this tank, hand regulated, and the tank provided with an overflow pipe into the sewer. This resulted in the waste of much hot water. By the aid of thermometers it was seen that the temperature of the water from the tank into the feed pump was 70 to 85 deg. F., and as a result, the heater did not condense all the exhaust supplied it, while the temperature of the water going into the boilers was 150 to 160 deg. F.

It was decided to install a return trap and receiver on the boiler room wall into which all condensate was to be returned and fed into the boilers while thus under pressure and saving much heat. Again, the load on the feed pump was accordingly reduced, effecting a saving due to less work required, less supplies, reduced slippage.

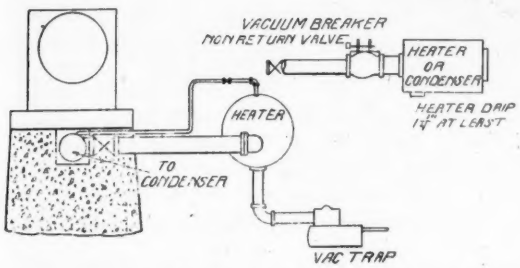
It was now found that the average temperature of water entering the heater was 36 deg. F., while entering the boilers it was 195 deg. F., yet some exhaust escaped from the heater. Another heater that was idle was connected tandem with the other and the two condense all the exhaust while the feed on entering the boilers is 208 deg. F.

In a 500-hp. condensing plant I put a heater in the exhaust line between the low-pressure cylinder and condenser as shown in the sketch, being connected on the induction plan. Due to the low temperature of the exhaust steam, the heater should be figured on a basis of 0.5 sq. ft. of heating surface per horsepower.

No heater ought to be connected in like locations unless it is provided with a sizable drain of at least 1¼-in. pipe connected to a reliable return or vacuum trap of ample size.

The instalment of one of the forms of vacuum breaker and non-return valve between the heater and cylinder is good insurance against wrecks from water coming from a leaky heater.

In the operation of the stoker and fan layouts, it was found that the best results were obtained when the



HEATER CONNECTION BETWEEN ENGINE AND CONDENSER

induced draft fan started first and slowed down after the under grate fan and stoker had slackened their speed, which was accomplished by weighting the pressure regulator controlling the induced fan 1½ lb. heavier than the other regulator. RECEIVER.

Effect of Air in Heater

THE FOLLOWING facts may be of value to readers of Practical Engineer as showing to what extent air may act as an insulator between exhaust steam and feed water in an open heater.

A 15,000-hp. heater of the type as shown in Fig. 1 was installed in a power house. There were 3 vents to the atmosphere, one on top, one on the side, and one on the steam end, the last two being just above the normal water line. Water was supplied to this heater by a tank pump which took its suction from a hot well as shown in Fig. 2.

The 12-in. suction pipe passed through the wall of the hot well and was extended by means of an elbow and tee some distance below the water level. Into a side outlet of the tee was connected a 6-in. pipe coming down from over head and which brought the condensed steam from a 2000 and a 5000-kw. steam turbine equipped with surface condensers. This peculiar connection was made in order that all the condensed steam, which was considerably hotter than the rest of the water, should go directly to the tank pump and not mix with the much larger bulk of water from the jet condenser of the 7500-kw. unit, and in this way send much of the heat out through the main discharge from the hot well.

It was observed that even when there was 2 lb. back pressure in the heater and steam was blowing from all 3 vents, it was impossible to heat the water above 170 deg. F. except at rare intervals. For several weeks, various changes were made in a vain effort to raise the temperature within the heater. Finally, the engineer decided that there must be an excess of air coming in with the water, and in a search for this air he disconnected the 6-in. pipe bringing the condensed steam, at the joint A B, Fig. 2. Breaking this joint allowed

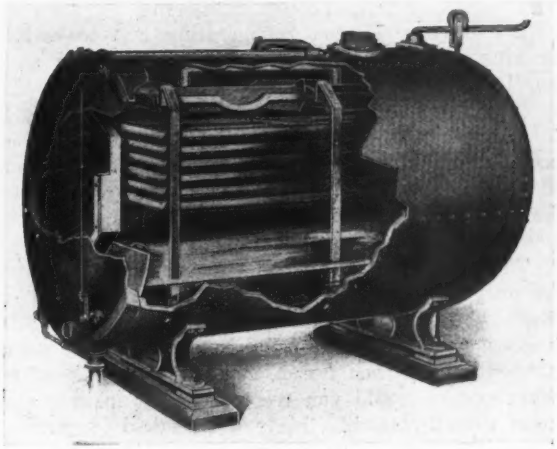


FIG. 1. TYPE OF HEATER EMPLOYED

the water to fall freely through a space of 2 ft. and mix with the other water in the well, thus giving an opportunity for whatever air there may have been entrained in the water to escape. The result was almost immediate. The temperature of the water in the heater rose to between 210 and 220 deg. F. depending upon the back-pressure carried in the heater, and incidentally the tank-pump has run more smoothly and with less breakage of valves and valve stems than previously.

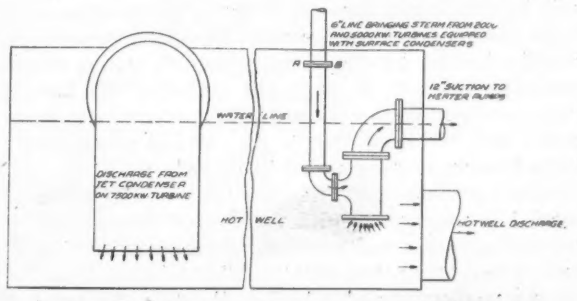

6" LINE BRINGING STEAM FROM 2000 AND 5000 KW TURBINES EQUIPPED WITH SURFACE CONDENSERS
A
B
12" SUCTION TO HEATER PUMPS
WATER LINE
DISCHARGE FROM JET CONDENSER ON 7500 KW TURBINE
HOT WELL
HOTWELL DISCHARGE

FIG. 2 DIAGRAM OF HOT WELL CONNECTIONS

Evidently there was a considerable amount of air entrained in the condensate from the turbines. This air could not escape and was carried on through the pump into the heater. Just how it disposed of itself therein and just how it prevented the proper mixing of the steam and water is a matter of conjecture. It is not probable that this air lay together in any one place, but rather that it so surrounded the particles of water or steam as effectively to separate the one from the other.

"C. A. J."

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Refrigeration Problems

WE HAVE a 7½-ton refrigerating and ice-making machine, and I would like a little information as to how I may obtain the best results. At the present time we are making ice and refrigerating one room 16 by 20 ft. The ice tank contains 42 cans, set in 3 rows, each can holding 50 lb. of ice. The high pressure gage shows 80 lb. and the low pressure gage shows 5 lb. Would the ice freeze faster if the load on the machine were increased, so as to raise the pressures on the gages?

There is plenty of ammonia in the system. Should the purging valve be left open until the ammonia gas shows white like steam, regardless of how strong the fumes may be? We are using condensed steam for ice making, which, when frozen, makes a white cake of ice. What system would you recommend for making clear ice in a small plant like this? What would you estimate the cost to be? How do you figure the load on an ammonia compressor? D. C. C.

A. The greatest capacity of a compressor is obtained with a high back pressure and a low head pressure.

The amount of ammonia that a compressor can draw in per stroke is increased as the back, or suction, pressure is increased, because the weight per cubic foot is greater at high pressures. For instance, at 5 lb. gage suction pressure, a cubic foot weight 0.0742 lb., while at 15 lb. gage, a cubic foot weighs 0.1089 lb.

On the other hand, the lower the head pressure, or high pressure, is carried, the less will the gas have to be compressed before discharging, hence the greater will be the weight discharged for a given amount of work done by the compressor. The high pressure is usually limited by the temperature of cooling water available, as at 80 lb. gage, the ammonia will have a temperature of 53 deg. at saturation, so that your water would have to be not over 45 deg., or else an extremely large amount of water would be needed.

On the other hand, the suction pressure must be carried low enough to give the desired temperature in the cooling rooms and ice tank. Your pressure of 5 lb. is, however, lower than could possibly be needed, as this gives a temperature of —16 deg. F., while for freezing ice, the temperature usually carried is about 10 deg. above zero Fahrenheit, corresponding to about 15 lb. back pressure. Carrying the back pressure so low, results in rapid freezing of the ice, which is one reason why you get white ice, as it does not give time for the air to separate out.

We have no tables of compressor capacity running as low as 80 lb. head pressure, since it is almost never that a cooling water of low enough temperature is available to permit carrying such a pressure; but with 103 lb. (the lowest given), with a back pressure of 5 lb., it will take about 5.6 cu. ft. ammonia pumped per minute to give one ton refrigeration capacity, while with 15 lb., it will take about 3.6 cu. ft. per min. for one ton capacity. Approximately, the same condition would obtain with a head pressure of 80 lb.

The best way to tell when you have purged sufficiently is to close the liquid outlet and hot-gas inlet valves of the condenser coils to be purged, and allow a liberal supply of cooling water to flow over them for some time. This will condense all the ammonia gas. Then, connect a small rubber tube to the purge valve and immerse the other end in a pail of water. Open the purge valve, and so long as permanent gases are escaping with the purge valve slowly opened, the gases will rise to the surface of the water in bubbles. When the permanent gases are all gone, the bubbles will disappear, as the ammonia gas will be dissolved in the water, giving a sharp crackling sound, similar to that when steam is blown into water.

It is better to purge rather slowly than rapidly, as if the purge cock is open wide, the pressure will blow out considerable ammonia with the permanent gases. For this reason, the ammonia smell is not an indication that the permanent gases are all removed.

So far as preventing white ice is concerned, it is difficult to say why this occurs without knowing the complete equipment of your plant. Probably it is due to air present in the ice. If the distilled water is not reboiled to remove the gases, it will be necessary to let it stand for some little time so that the air may work out. The air and other gases will also be thrown out of the water during the freezing process, if the freezing goes on slowly, and the rapid freezing, due to your low back-pressure, is one of the things that causes the white ice.

It is impossible to give any accurate estimate on the cost of icemaking without knowing the cost of installation of the plant, price of coal, wage scale, and other local conditions. An estimated cost for a plant of your size is as follows: Considering 3500 lb. of bituminous coal used per 24 hr., at a cost of $3 a ton delivered to the plant, total daily expense would be $11.70; expense per ton of ice, $1.47. This is operating expense only. It does not include interest, taxes, depreciation, or upkeep of the plant. It is based on rather a low wage scale.

The load on an ammonia compressor is figured from the mean effective pressure and the revolutions per minute. To get the mean effective pressure, we must work with the absolute pressures in the ammonia cylinder. We have the following formula:

$$\text{M.E.P.} = p_o\left[1 + \text{hyp. log}\frac{p_1}{p_o}\right] - p_o$$

Where P_1 is the head pressure absolute, and P_o the suc-

tion pressure absolute. This mean effective pressure is then multiplied by the area of the compressor piston, in square inches, by the length of the stroke, in feet, and by the revolutions per minute for a single acting compressor, divided by 33,000, giving the horsepower developed in the compressor cylinder. To get the horsepower of the steam end, there must be added to this about 25 per cent to take care of friction losses.

The refrigerating load, in tons capacity, depends, as already indicated, on the head and back pressures. Approximately, for usual conditions, 4 cu. ft. compressor capacity per minute will equal one ton refrigeration in 24 hr. For standard conditions, 185 lb. head pressure and 15.67 lb. back pressure, it has been proposed that from 27 to 28 lb. of ammonia pumped per hour will be considered equivalent to a ton of refrigerating effect, which corresponds to the 4 cu. ft. per min. above mentioned. A. L. R.

Vacuum Pump Trouble

WE HAVE a Corliss engine-driven Alberger 2-stage, 24-in. cylinder vacuum pump which is causing us much trouble with water appearing in the second stage (vacuum) cylinder, or the one discharging to atmosphere; there are no indications whatsoever of water in the first stage cylinder, that is the one connected to the condenser.

This trouble always occurs when starting the condenser and a vacuum of from 18 to 25 in. has been created, but disappears after the pump has been in operation for about 15 to 20 min. and the condenser is carrying a vacuum of, say, 28 to 29 in.

Drains are placed on both cylinders.

If you can give me any information or suggestions as to the cause of this trouble and its possible elimination, the favor would be much appreciated.

C. K. D.

A. It is hard to say just where this water comes from; but from the fact that the trouble always occurs when starting the pump and seems to disappear in a few minutes after the pump has been in operation, we are inclined to think that this water accumulates in the chest of the first-stage cylinder from where it would naturally be thrown over into the second-stage cylinder when the pump is put in operation, and eventually works out of that cylinder by evaporation and is carried off with the air to the atmosphere.

There are cases where vacuum pumps discharge into an outboard exhaust pipe, and if this pipe line is in use while the pump is shut down, condensation will work back into the second-stage cylinder. Also, in cases where the throttle valve on the main engine or turbine leaks steam while the turbine is out of commission, this steam might pass over through the condenser and accumulate in the vacuum pump while it is standing idle.

There is also a possibility of a jacket water leak into the second-stage cylinder. This will happen if the gaskets under the cylinder heads are not in good condition where the cylinder jacket connects with the head jacket.

Both cylinders and both air valve chests should be thoroughly drained before putting the pump in operation, and it is advisable to turn the pump over once or twice with all drain valves open before steam is put on. It is then necessary to close the cylinder drains and the first-stage air chest drains, but the second-stage air chest drains might be left partly open while in operation.

Why the water trouble occurs only with the lower vacuums and not with the high vacuums we cannot say, but think it possible that it is the presence of water which causes the low vacuum rather than low vacuum having anything to do with the water getting into the cylinder. ALBERGER PUMP AND CONDENSER CO.,

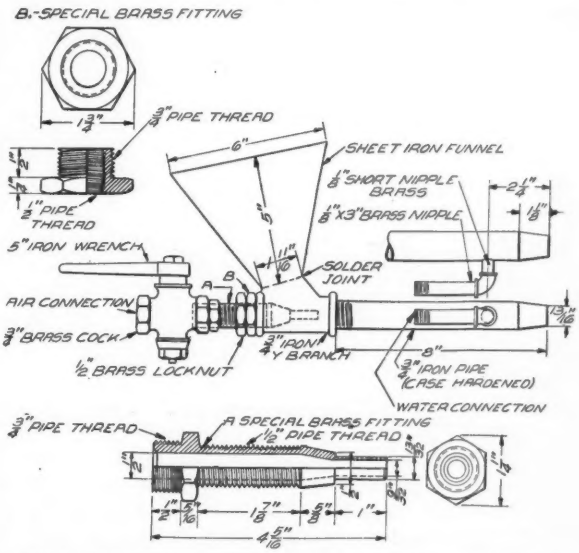
G. P. SYMANCK.

Cleaning Condenser Tubes with Sand Blast

How MAY condenser tubes be cleaned by means of a sand blast? G. P. W.

A. One sand-blasting nozzle consists of a short length of pipe with a water connection on one side and an air connection with a cock at the rear. A funnel discharges the sand directly in front of the air inlet.

In operating this apparatus, the water supply is cut down to a very fine stream, the nozzle inserted in the



SAND BLASTING OUTFIT FOR 1-IN. OUTSIDE DIAMETER CONDENSER TUBE

end of the condenser tube, and after a quart of clean, dry, sharp sand is poured into the funnel, the air-cock is opened full. About 20 sec. are required to drive a quart of sand through the tube, and it is claimed that one operator can clean from 100 to 120 tubes an hour.

W. P.

THE INDUSTRIAL BUREAU in France wishes to buy all kinds of electrical apparatus and supplies, quotations to be c.i.f. French port, with credit opened in the United States to cover purchases. Correspondence should be in French, and further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C., referring to item 24,335.

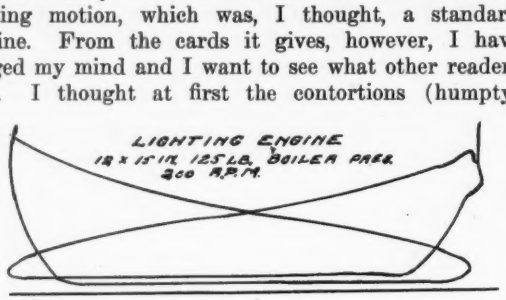
"WHATSOEVER a man has done, whether good or evil deeds, not one is of little importance: they all bear some kind of fruit. Our deeds, whether good or evil, follow us as shadows."

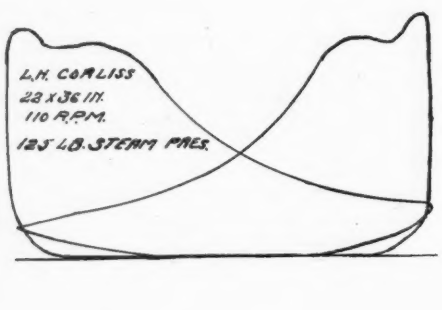
Problems For Discussion By Readers

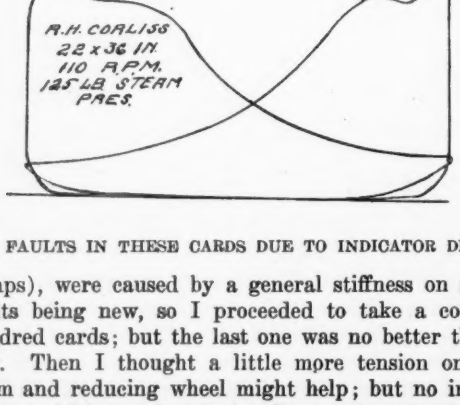
What Would You Do If You Had These Conditions To Meet?

Is the Indicator at Fault?

THREE indicator cards are enclosed upon which I desire comment. Two of them are from a twin Corliss, the other is from a slide valve engine with fly ball governor. They were taken with a new indicator and reducing motion, which was, I thought, a standard machine. From the cards it gives, however, I have changed my mind and I want to see what other readers think. I thought at first the contortions (humpty-







ARE FAULTS IN THESE CARDS DUE TO INDICATOR DEFECTS?

bumps), were caused by a general stiffness on account of its being new, so I proceeded to take a couple of hundred cards; but the last one was no better than the first. Then I thought a little more tension on paper drum and reducing wheel might help; but no improvement could be made. I got disgusted, and taking the machine home I wrote the company, sending them some cards, and asked them how they wanted it returned.

I have these engines set with 5/16-in. steam lap, 3/16-in. exhaust lap and nearly 1/16-in. lead. Valve gear, dashpots, etc., work free and snappy. Cylinders were rebored and new piston heads and rings installed recently. The release is rather late and if I shorten the radial rods, it will reduce my compression which I do not think any too much. Of course, I could advance the eccentric, making everything earlier; but that would make cutoff too early. It is a single eccentric machine. The data on card is as follows: Engine 22 by 36 in.; speed 110 r.p.m.; steam pressure 125 lb.; scale of spring 70 lb. The cards from the left-hand and right-hand engine are nearly the same, which, in my judgment, only goes to show that the fault is in the machine. It is not caused by excessive lead, as cards do not show enough lead to bring admission line at right angles to atmospheric.

E. C. D.

Operating Gas-Engine Compressors

CAN ANY of the readers of Practical Engineer give me some suggestions relative to the operation of direct Bessemer gas-engine compressors?

I also would like to know how I may overcome the leakage of oil from crank case through piston rod of power end.

C. J. T.

Examination Questions from Massachusetts

THE LETTER of G. R., on pages 366 and 367 of the April 15 issue, has attracted my attention, and having had experience with Corliss engines, condensing and noncondensing, I would like to add my little say relative to the matter under discussion.

Ordinarily, it is considered proper to give the low-pressure exhaust valves of a condensing compound engine considerable lap, in order to produce compression in that cylinder, and thereby insure quiet and smooth running of the engine as a whole. The amount of compression to aim for in the cylinder of any steam engine is largely a matter of judgment on the part of the operator. Mathematics have been applied to discover just what degree of compression is the most economical for any given case, but it is seldom practicable to apply such rules unless all the attendant conditions are known and taken into consideration. I am one of those who favor as little compression as posible in slow and medium speed engines.

If a cross-compound Corliss engine be adjusted for high compression when running condensing, then, if anything happens, to require the engine to be run noncondensing, the low-pressure steam valves will undoubtedly rattle and slam, for the high compression, under noncondensing conditions, will lift the steam valves from their seats at each stroke of the piston. The com-

pression pressure will rise higher than the receiver pressure, and thus will you get an alternate slam. I once had charge of a pair of such engines, 24 and 48-in. by 4 ft. stroke, cross-compound, condensing Corliss of 2000 hp. each. At low tide, and at peak loads, we occasionally "lost the vacuum," and the automatic atmospheric valve would enable the engines to continue running, but noncondensing. The low-pressure valves had been set to give considerable compression, and so they slammed.

To meet the emergency, we reduced the amount of compression in the low-pressure cylinder, and the slamming of the valves ceased. We were somewhat doubtful, though, as to what would happen when the engine was cut into the condenser again. In spite of all that had been said, we were overjoyed to find that the engine ran better than ever with the reduced compression, both condensing and noncondensing. We had no further trouble with those engines after the change had been made.

From this we learn that one valve setting will do for both condensing and noncondensing conditions, provided the compression is as low as consistent with good judgment; but if in the first place too much compression has been given the low-pressure cylinder, then it must be reduced for quiet running, noncondensing. Of the two evils, too much or too little compression, I prefer the latter. For all-round practice in good running, and economy in the use of steam, let the load on the engine act as a brake and check to the moving parts, rather than compressed steam in the cylinder. The less the compression, the greater the load the engine will carry, with a given quantity of steam. CHARLES J. MASON.

IN REPLY to the communication of G. R., appearing on pages 366 and 367 of the April 15 issue, relative to the re-setting of Corliss engine valves when changing from condensing to noncondensing, and vice versa, I would like to relate an experience I recently had.

Some time ago, we changed a 560-hp. Erie City cross-compound engine having the Corliss type of exhaust valve from noncondensing to condensing and although I was informed by one I considered a good authority on the subject to the contrary, I found it necessary to change the valve setting. Before doing so, I noticed that upon starting up condensing, there was a bad pound in the low-pressure cylinder and in order to do away with this, I had to increase the compression on that cylinder until the indicator diagram showed approximately the same amount of compression above the atmospheric line as when running noncondensing.

The receiver pressure dropped from 40 lb. noncondensing to 22 lb. condensing with 26-in. vacuum.

H. I. REEDER.

ON PAGE 367 of the April 15 issue, G. R. expresses his doubts of an engine operating satisfactorily condensing, when the valves are set for noncondensing operation.

My experience with engines of the Corliss and grid types has been, that if set for smooth and economical operation noncondensing, they become noisy when operated condensing, and if set for condensing operation, the relief valves will pop, or, in the case of the grid type, the steam valves will lift off their seats should the vacuum fail.

Some time ago, I became interested in this subject, and secured cards from smooth running noncondensing, simple condensing and the low-pressure cylinders of compound condensing engines.

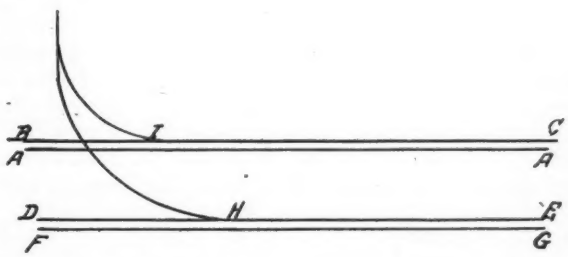
The cards from the noncondensing engines showed 5 per cent compression and the condensing engines averaged 12 per cent compression. By that I mean that the exhaust valve was line and line with its port when the piston was 12 per cent from the end of its stroke.

W. E. BARBER.

FOR THE BENEFIT of G. R., whose inquiry as to quiet running of an engine when run noncondensing with the exhaust valves set for condensing, the following discussion is given.

Some do not understand how we can get compression in a condensing engine, claiming that, as a vacuum is less than nothing, we have nothing to compress.

The illustration represents the atmospheric line as drawn by an indicator. All pressures above it are above atmospheric pressure, which, at about sea level, for ordinary calculations may be called 15 lb. When the back pressure line of a card is as shown at BC, the distance between BC and AA shows the back pressure above the atmospheric.



ATMOSPHERIC LINE AS DRAWN BY AN INDICATOR

When a condenser is in use and the engine exhausts into a vacuum, the back pressure line on the card appears as at DE, and being below line AA and to scale, represents the pressure below the atmosphere the piston moves against and is explained in this way.

As it is impossible to create and maintain a perfect vacuum which would be shown on the card by another line, FG, located to scale about 15 lb. below line AA, a pressure of some magnitude always exists and makes some resistance for the piston to overcome.

When the engine runs condensing, to secure proper compression, since the existing pressure in the cylinder is 2 lb. absolute with a 26-in. vacuum, the exhaust valve has to close, as shown at H, to trap a sufficient volume of steam in the cylinder to enable the pressure to build up to the proper amount when the crank arrives on the dead center.

When run noncondensing, of course, the pressure to begin with is higher and as a result, a smaller volume is required to obtain a final presence equal to that obtained for compression when running condensing, the exhaust valve closing at I, for example.

The valves in most engines, even when new, have some movement in their chest to allow for expansion and, due to wear, such movement will increase. When the pressure of compression rises to a certain point, it will be above that in the steam chest, so the steam valves

will move away from their seats, and when the difference in pressures is reversed, will return to their seats, usually making a pound in doing so.

It is always desirable to stop the engine when the valves are set for condensing and change the length of exhaust rod or move the exhaust eccentric to reduce the compression to that required for running noncondensing, not only to secure a quiet running engine, but it also reduces the strain and wear on the parts and reduces the liability of accident due to a valve breaking and getting caught somewhere.

When an engine running condensing is deprived of the vacuum, its load is increased an amount equal to that removed when the condenser is in operation. The result is that unless the engine is run under load, it will not carry the load, in many cases, with the usual receiver pressure, so the proper thing to do is to raise the receiver pressure an amount equal to that pressure the condenser removes, add the atmospheric pressure and 2 or 3 lb. more to overcome the added friction.

Generally the necessary steam to raise the receiver pressure as described, is obtained by admission of live steam through a reducing valve into the receiver.

RECEIVER.

Why the Corroded Fittings?

REGARDING the inquiry of R. M. appearing on page 326 of the April 1 issue, I believe that his trouble is due to the use of unsealed steam traps, which, when discharging, allow steam to pass through to the tank, and this steam when coming in contact with the water causes considerable hammering. This leakage of steam is generally found in the expansion and old style of traps.

Relative to the corrosion of the fittings, I would say that if compound is used in the boiler, this is undoubtedly the cause of the trouble, especially if the compound is quite strong. If compound is employed, I would suggest changing to a weaker one.

If the boiler feed pump is of small size, place a butterfly valve in the steam supply line operated by means of a float in the tank. Remove the baffle plate.

H. W. H.

I WOULD SAY that the rapid deterioration of the fittings indicated in System A could be laid to the ever-changing temperatures and consequent expansion and contraction of these fittings at the joints. The mixing of hot and cold water at this point precipitates corrosive agents which always work their way into loose threads or joints. The 3-in. distributing pipe of System A, although perforated, is shown open at the end. This should have been capped, and the pipe rigidly supported to reduce vibration. Another possible cause of rapid corrosion would be the difference in materials. If the fittings were brass, and bolted next to iron or steel, they would quickly corrode.

The reason for the hammering in System A each time a trap is discharged, was that the water in the tank was in a state of rest, and the force of the incoming hot returns entered into this cooler water with such violence that the hammering was the result. Had some means been provided to make the incoming returns promote a continued circulation or movement of the body of water, it would not only have prevented the hammering, but would also have distributed its heat more thoroughly to the well water.

In System B, the reason for the seal becoming broken is that the pressure formed on the surface of the water from the incoming steam drains, forces the level down until it is below the baffle or seal plate on one side, and up on the other, until some of it escapes in the overflow, the steam afterward escaping in the vent pipe. My opinion is that System B is poor, from both operating and economical points. The steam from the returns is only in contact with the surface of the well water, and the inside of the tank above water. This takes longer to condense it, and also allows building up a back pressure in the tanks and against the trap. This back pressure will be equal to that required to force the water level down to the point where the steam can escape to the other side of the baffle or seal plate.

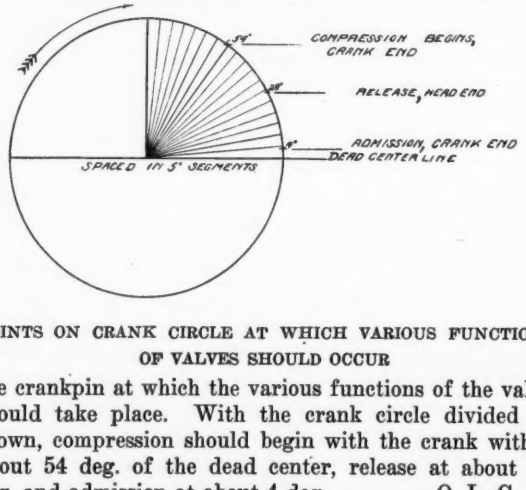
On page 311, of April 1 issue, is an excellent article by T. W. Murphy, dealing with noiseless heating of water in closed tanks, which will equally well apply to hot wells receiving steam trap returns, the point being to stop noise.

C. H. WILLEY.

Why the Knock?

TO ME the trouble related by J. A. W., on page 327 of the April 1 issue of Practical Engineer, would appear to be due to release occurring too late. I would move the eccentric ahead until release takes place at the proper time.

In the accompanying sketch, I have attempted to indicate graphically the points in the path of travel of



POINTS ON CRANK CIRCLE AT WHICH VARIOUS FUNCTIONS OF VALVES SHOULD OCCUR

the crankpin at which the various functions of the valve should take place. With the crank circle divided as shown, compression should begin with the crank within about 54 deg. of the dead center, release at about 28 deg. and admission at about 4 deg.

O. L. C.

What Is Your Opinion?

REPLYING to the letter of J. C. L., page 365, April 15 issue, I recently had the same trouble, and if he will follow the same course I did, he may obtain satisfactory results.

The commutator was practically new and ran all right for several months, when it began sparking badly. When shut-down time came, I found the bars in the condition described by J. C. L. I turned up the commutator in a lathe, first noticing that the mica between segments next ahead of burned spots was very hard. After turning up, I undercut the mica between all segments and had no more trouble until the copper wore

down again, when, as an experiment, I undercut the hard strips only and obtained satisfactory results.

It would seem that a few strips of the mica were harder than the copper, and when the latter wore down, this caused a spark. R. G. PARKER.

I BELIEVE that if the generator referred to by J. C. L., on page 365 of the April 15 issue, is of the direct-connected type, he will find his trouble due to the main bearing on the commutator end being worn, allowing the commutator to break contact with the brushes whenever the crank or cranks are passing their dead centers. Trouble I recently experienced similar to this was remedied by rebabbiting the bearing.

CHAS. D. DYER.

Operating Barometric Condensers

IN COMPLIANCE with the request of W. E. B., page 326 of the April 1 issue, I would say that we must take into consideration the probable cause of losing the vacuum. There are several causes why a vacuum created by a barometric condenser may tend to drop, among which are the following:

(1) Insufficient injection water.
(2) Leakage of air into condenser.
(3) Condenser too small.
(4) Dry vacuum pump not working properly.

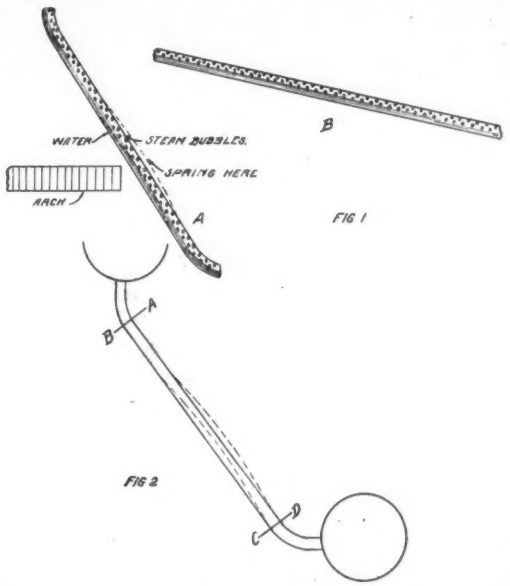
We must always remember that when the vacuum is lost, so is also the main injection water. If I lost my vacuum on account of insufficient injection water, I would leave the engine running and work the vacuum back with the forced injection. C. M.

Boiler Operation Questions

AFTER STUDYING the subject of the cause of boiler tubes buckling upward, I have decided that there are at least two forces which bring this about.

In my opinion, the principal cause is that the upper side of the tube reaches a higher temperature and thus expands more than the lower side, for the reason that the water passing through the tube is being rapidly evaporated, and as the steam bubbles have a tendency to rise, they fill the upper part of the tube, as shown in Fig. 1 at A and B, which represent tubes of Stirling and Heine boilers respectively. Steam does not have the same absorptive properties as water, and does not absorb the heat from the fire as rapidly as the lower side of the tube, which is covered with more solid water, thereby allowing the upper side to assume a higher temperature. In the Stirling boiler, upward bending is augmented by the shape of the tube.

Referring to Fig. 2, the distance from the drum to point A at the top end is not so great as the distance from the drum to point B on the opposite side, as it is the arc of a smaller circle, and in expanding, would tend to throw the lower end back toward the baffles. On the lower end, the distance from the mud-drum to point C is greater than the distance from the drum to point D, which would also throw the upper end back, and as both ends are secure, the tube is bent in the weakest part, just above the end of the dutch oven arch, at which point it is at the highest temperature. This action is in the same direction as that caused by the steam bubbles. I agree with Mr. Wallace that repeated drafts of cold air striking the lower side of the tube while cleaning fires would tend to contract the lower side of the tube and drive it upward, as the temperature of the upper side of the tube would be higher, due to the nature of the water contained therein, and also to the accumulation of soot on the top side. This action would assist those described above in bending the tube upward.



ILLUSTRATING ACTION OF HEATED BOILER TUBES AS SET FORTH BY J. H. CASE

A coating of scale in the tube is usually of about the same thickness in all parts of the tube, and would cause it to become overheated, thus increasing the bending action. J. H. CASE.

What Is Wrong?

FROM THE indicator cards submitted by A. L., and as published on page 326 of the April 1 issue, it appears as if the pick-up did not work properly on the (left-hand) crank end; the valve stem packing may be too tight or the valve may for some other reason work hard.

It might be advisable to give the engine a little later cutoff on the (left-hand) crank end, and for economy's sake I would lower the boiler pressure so as to get about ¼ cutoff on both ends. C. M.

Thawing Water Pipes

READING THE LETTER of L. M. Johnson, page 243, of the March 1 issue, brought to mind the method I successfully employed last winter to thaw out a 2-in. line under a powder house containing 18 or 20 tons of dynamite. I sprinkled the frozen pipe with carbide, such as is used in miners' lamps, and wet it with water; in 2 min. the pipe was too hot to touch. H. A. HIGHRITER.

ACCORDING TO A DECISION made by Harry J. Dingeman, corporation counsel of Detroit, in response to a resolution from the city council asking him to draw a charter amendment empowering the city to operate a coal yard to prevent fuel famines and high prices, the Michigan constitution does not give the city power to operate such enterprises.

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At War

By act of Congress, approved by President Wilson, this United States of America has entered the great struggle to establish and perpetuate the principles of liberty and democracy for the world.

It is idle to think that the struggle will soon be over. Such a belief can come only from serious undervaluing of the powers of resistance and endurance of the great war machine that has been built up in the countries of central Europe under the direction of the Prussian autocratic rule. Every individual interest is there subordinated to the one great project of overcoming the allied forces and the allied nations. For war is now a struggle of nations against nations and every citizen must contribute his full share if success is to be attained.

In his proclamation of April 15, President Wilson defines clearly the cause for which we are fighting, "The rights of mankind and the future peace and security of the world." He then specifies in detail the "things we must do and do well, besides fighting—the things without which mere fighting would be fruitless," and he might have added, will be impossible.

We must supply abundant food for ourselves, our armies, our seamen,—and for a large part of the nations with whom we have now made common cause. We must supply ships by the hundreds to carry materials to the other side, and no matter how many ships are sent to the bottom, their places must be supplied, and at once.

From our fields, our mines and our factories must come full measure of materials to clothe, equip and support our forces on land and sea as well as our people who are at work to furnish those forces with their equipment. We must also help to clothe and equip the armies in Europe with which we are cooperating, and supply raw materials for those factories in Europe which are making clothing, arms and munitions for the allied armies.

Fields, mines, factories, shipyards, must be made more productive and more efficient than ever; and men and women whose thought and energy are devoted to these things will be serving the country as truly and effectively as the men on the battleships or in the trenches, if they give to the work the same wholehearted devotion and spirit of self sacrifice as do those who go forth to brave danger and death in the first lines of defense.

In the production of foodstuffs, it should be the business of every community and every individual to see that no land which may add to the crop is allowed to lie idle; that everyone who can do so, aids, to the limit of his possibility, in cultivation and harvesting, that there is no manipulation of the supply by those who would take advantage of the emergency to secure inordinate profits, that handling and transportation are rapid and effective to prevent delay and waste.

Every man, every boy who plants and cultivates a garden adds to our resources. Every woman who reduces waste and extravagance in her household helps to conserve our resources. Not only in our daily labor, but in our daily living lies opportunity for service, for fulfilling a public duty and proving our patriotism.

We need to face with grim determination the long, earnest effort that is before us if success is to come to

our cause. And to begin—at once—to practice economy, self-denial, diligence in business, the spirit of service for the common good.

As President Wilson says, "The supreme test of the nation has come. We must all speak, act and serve together."

Bettering Bearing Lubrication

Energy supplied to an engine is consumed in 3 ways: in doing the actual work required, in overcoming the inertia of the moving parts, and in overcoming friction. Value is received for the amount expended in doing the required work, and most of the energy expended in overcoming inertia of the moving parts should be returned somewhere during the work cycle, but the energy lost in friction is a direct waste.

Due to a lack of information on the laws of friction, and to the fact that friction leaks were largely invisible and difficult to measure, designers of the earlier engines did not give the proper attention to the bearings. The engine had a few holes which were treated frequently to a dose of oil, and only when a bearing became dangerously overheated, or the babbit began to run out, was the engineer aware of the power lost in friction. To a large extent, friction was looked upon as a cureless evil.

With the introduction of higher speeds and the ever-increasing demand for greater engine efficiency, the necessity for better bearing designs and improved lubrication became imperative. As a result of research work begun in 1883, valuable data on bearings was soon established. Experiments brought out the requirements for bearing pressure allowance, relations between bearing pressure and velocity, pressure distribution, and the advantages of complete or flooded lubrication.

Attention has been directed more and more to the subject of lubrication. Remarkable advancement has been made in developing devices that will feed lubricant efficiently under all conditions, and the modern lubricating systems, made suitable to various arrangements of power plant equipment, are effecting material savings in operating expenses.

Economical bearing lubrication consists primarily in supplying as much lubricant as the bearings need, and of collecting, filtering, and using it repeatedly. Efficient bearing lubrication lengthens the life of the machine, saves a large amount of power expended for excessive friction, reduces fuel consumption, and smooths out the wrinkles in the engineer's brow. In perfecting central, group, and individual automatic oiling and grease systems, to provide for continuous and adequate feeding, the lubrication engineer has contributed a valuable service.

Editorial Comments

THE WORLD'S LARGEST ICE SKATING ARENA is interesting not alone as a novel pleasure resort, but it represents a new field for the power plant. As will be noted in the leading article of this issue, the power plant equipment required is essentially the same as that for a refrigerating plant except for the conditioning of the air. To maintain the ice floor in proper condition would undoubtedly require some experience, but an engineer familiar with refrigeration plants could soon learn to handle the mechanical side of an ice rink. When operated in connection with an ice plant, an ice skating arena should give a profitable load for the plant machinery during the slack season.

INJECTORS are the simplest means for feeding water to boilers, but in the modern power plant they are employed almost exclusively as auxiliary feeders, and as such they should be thoroughly understood by the men who handle them, and kept in perfect condition. In this issue a series of articles is begun which will familiarize the reader with the essential principles and details of modern injectors for stationary boilers.

HANDLING LUBRICANTS in large quantities at power plants or industrial establishments is a problem confronting many engineers, and although your conditions may not warrant the equipment and elaborate system described by Mr. Battle in this issue, a number of suggestions which he makes may be applied to good advantage in any plant. The proper handling of oils will usually result in economies which are not foreseen.

AM I WASTING COAL? It's a crime against society if all knowledge and equipment available is not employed in utilizing every possible heat unit in the coal we burn. Mr. Hays tells us of some wastes which prevail and with our attention called to them it is our duty to see that these wastes are stopped.

STARTING CURRENTS FOR DIRECT CURRENT MOTORS should not be overlooked in planning circuits, but the great difficulty has been to determine just what this current might be. Mr. Walsh, in this issue, gives a formula for determining this so that there need be no more guesswork along this direction.

THE HIGH HEAD ELECTRIC POWER PLANT IN BRAZIL contains water turbines which effectually solve the problem of close regulation under extremely high pressure by employing nozzles with swinging bascules directing the water onto the buckets of an impulse type turbine. A detailed description is given by Mr. Perkins.

HOW TO INTERPRET INDICATOR CARDS FROM DIESEL ENGINES is undoubtedly one of the requisites of a successful operator. Mr. Neale gives some excellent pointers on this subject and experts in the use of the indicator will find valuable information here.

LETTERS DIRECT FROM THE PLANT, selected for publication in this issue, all contain information of more than passing value, but particular attention is called to Mr. Teiper's letter on the Capacity of Condenser Pumps. This problem comes up every day and the solution should be made familiar to all. The Effect of Air in the Heater is also of extreme importance for a low feed water temperature may be due to this cause. Also in Problems for Discussion by Readers a number of our best engineers give their views upon changing from condensing to noncondensing, and the causes of corroded fittings.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Automatic Pole-Type Transformer

THE first automatic, pole-type constant-current transformer for use with series street lighting systems, at points distant from the central stations has been perfected by the General Electric Co.

Its theory of operation is identical with that for station-type, constant-current transformers. The unique feature of this type is that it is mounted on a pole and is operated by an oil time switch. There are no new and untried principles or parts. It is a consolidation of various features previously tried and proved right in other types of transformers which have been on the market for a long time.

It is entirely automatic in operation, submerged in oil, mounted in a weather-proof tank and requires no

NEW GENERAL ELECTRIC POLE-TYPE TRANSFORMER

care or attention after it has been properly installed. While it is generally an "outdoor" device, for indoor use it may be mounted on the station wall or ceiling if floor space is at a premium.

This Type R. O. transformer fits into the lighting companies' systems where transmission conditions arise which would require a substation with control panels and attendants, but where the amount of business obtainable and construction costs make such an installation impracticable.

Heretofore, it has been difficult to provide street lighting for small towns, villages and suburbs where the revenue derived would not be sufficient to warrant such an installation.

The growth of these outlying districts has been so rapid that it has been almost impossible for the facilities of the lighting companies to keep pace. When it becomes impracticable to run circuits from the control stations, on account of the distance and the copper required, it is not always advisable to erect a substation. In many cases, the growth of these communities is so rapid that there has been an interval before the substation could be erected, during which the lighting service is hard put to be efficient and effectual.

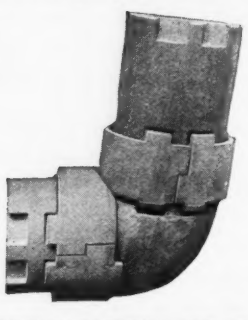
The Type R. O. transformer was designed for this service and to fill this demand. These transformers possess current regulation as close and through as wide a range as is given by the best station type constant-current transformers. The current from full load to no load is maintained within 1 per cent of normal. This feature alone materially prolongs the life of Mazda lamps operating on a circuit controlled by such a transformer. The efficiency is the same for the station type transformer and has a high power factor.

For the operation of Mazda C lamps this transformer has material advantages. It serves to protect the lamps at starting and acts instantaneously to check surges on the line which would shorten lamp life. It gives almost perfect regulation under all conditions.

The theory of operation being identical with that for the station type constant-current transformer, the design differs only in the requirements to make the transformer automatic. It will regulate satisfactorily when operated on circuits ranging from 2000 to 2400 v.

Covering for Blowoff Pipes

TO PROTECT blowoff piping from the heat of flue gases, the Interlocking Pipe Covering Co., of New York City, is offering a patent interlocking covering which is formed in halves and fitted with tongues as shown in the accompanying view. Covers for hand-



INTERLOCKING COVERING FOR BLOWOFF

holes are fitted to order according to the size and shape of the crowfoot brace.

In applying this pipe covering, an elbow is fitted first, then a section ring, and then a covering. It may be conveniently removed in case of boiler inspection.

New Design of Gate Valves

AVOIDS SCALE AND DIRT POCKET BY USING SLIDING SEAT. BY D. E. KEPPELMANN

IN the Improved Sliding Seat Valve the trap is eliminated and the opening and closing feature consists of a solid wedge with a port constantly riding on its seats located in the sides of the valve, creating a clean opening through the wedge.

This makes this valve self cleaning, for when open it presents a clean surface flush with the body of the valve, so that the foreign matter rides through, making it possible at all times to close the valve whenever necessary. When the improved valve is closed the foreign matter will accumulate against the wedge, but with the lifting of the wedge this accumulation is immediately cut from the wedge and carried by the liquid or gaseous substances into the line.

No bypass is necessary, for the seats are never exposed to the elements passing through, hence scoring is impossible.

Figure 1 shows the front view, and the opening through the wedge.

This valve can be used for gas, water, steam, oil, air and acids under low, medium or high pressures. It also readily adapts itself to a quick opening closing valve with but slight change in its construction.

Figure 2 shows the working parts of the improved valve. The sliding wedge when closed hermetically seals

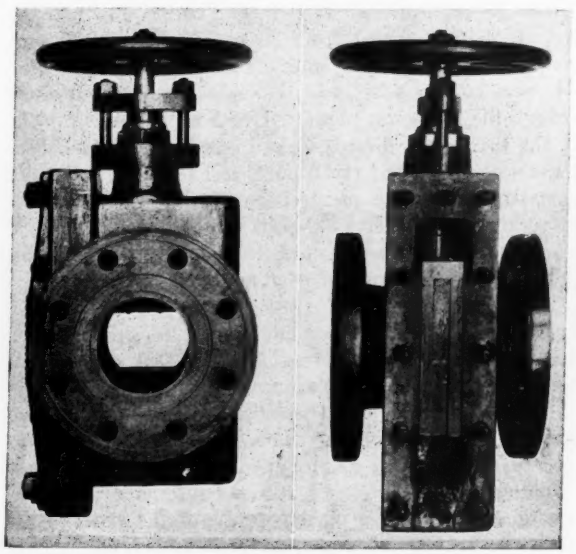


FIG. 1. FRONT VIEW OF IMPROVED SLIDING SEAT VALVE
FIG. 2. SIDE VIEW OF SLIDING SEAT VALVE WITH PLATE REMOVED, SHOWING WORKING PARTS

the valve. In shop practice it has proved clean and tight, after 6 mo. installed in the earth under actual working conditions.

The new valve can be installed in the line in any position, for the wedge constantly riding on its seats in a guide together with the pressure exerted by two elliptical springs prevents sagging of the wedge at all times when open or closed.

Figure 3 shows vertical and horizontal sections of the valve with the gate open. The gate slides on two wedge-shaped seats, 2, 2, and is pressed against them by semielliptic springs 15 and 16. When closed, wedges 9 and 10 force the gate tightly between the seats. These seats are fastened to the valve body and are machine finished. Springs 15, 16 and wedge 9 are carried by a removable plate, which acts as a cover on one side of the casing.

Screw 17 is threaded into the gate and turned by a hand wheel to slide the gate open or closed. The closed

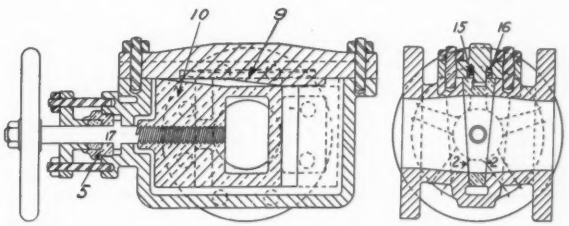


FIG. 3. VERTICAL AND HORIZONTAL SECTIONS OF SLIDING GATE VALVE

position is indicated by the dotted lines, the solid portion of the gate being then over the opening in the housing. The screw is held from vertical motion by a collar fitting between the recess in the housing and packing nut 5, and is packed by a stuffing box and gland.

Leakage between housing and side plate is prevented by a thin corrugated metal gasket.

News Notes

THE AMERICAN-RUSSIAN CHAMBER OF COMMERCE of New York announces that the 1918 edition of Industrial America, the handbook of industrial, commercial and financial information, together with a classified trade directory of American firms for use in Russia, is now in course of preparation. American manufacturers who are interested in the Russian field are invited to forward to The American-Russian Chamber of Commerce, information regarding their firms and their products for listing in the trade directory section of the handbook. There is no charge for such listing, the purpose of the directory being to place before the Russian purchasers the most complete and comprehensive list possible of responsible American firms who can supply the wants of Russian consumers. Proper forms for supplying information for the trade directory may be had by applying to The American-Russian Chamber of Commerce, Woolworth Building, New York.

PROFESSOR C. R. RICHARDS, who since 1911 has been head of the Department of Mechanical Engineering at the University of Illinois, and who acted for 2 yr. as Dean of the College of Engineering during an absence of Dean Goss, has been appointed Dean of the College of Engineering and Director of the Engineering Experiment Station of the University of Illinois, to succeed Dr. W. F. M. Goss, who has resigned to become president of the Railway Car Manufacturers' Association of New York City.

Dean Richards graduated from Purdue University in 1890, and has successively occupied positions as instructor in Mechanical Engineering in Colorado Agricultural College; Professor of Practical Mechanics, Professor of Mechanical Engineering, and Dean of the College of Engineering in the University of Nebraska, whence he went to the University of Illinois to take charge of the Department of Mechanical Engineering there. Dean Richards is a member of the American Society of Mechanical Engineers, Western Society of Engineers, Society for the Promotion of Engineering Education, and a number of honorary scientific organizations, including Sigma Xi and Tau Beta Pi.

TO CORRECT any false impression arising from a recent court decision on patent infringement, the Skinner Engine Co. states that the "Universal Unaflow" engine with auxiliary exhaust valves to lessen clearance is manufactured under a number of patents owned by the Skinner Engine Co., who believe that the final decision on appeal will show that these patents do not conflict with the Stumpf patents. It also informs present owners and future purchasers that they will be protected in case of any damage due to any alleged infringement.

U. S. CIVIL SERVICE COMMISSION announces an examination for assistant inspector of engineering material (aircraft). Vacancies occurring in the Office of Inspector of Engineering Material, Boston, Mass., Brooklyn, N. Y., and Pittsburgh, Pa., at $4.48 to $5.04 a day, and in positions requiring similar qualifications at any navy yard or other naval establishment, will be filled from this examination. Duties will consist in requiring contractors to carry out plans and specifications prepared by the Navy Department for machinery and material used in connection with air planes for the United States Navy and passing upon tests of such machinery and material. Competitors will be rated on general and technical education and experience. Applicants must be capable of preparing reports and of interpreting plans as presented in blueprints and specifications. They should have a thorough knowledge of the assembly and operation of gas engines in general and particularly of those types of engines used in air planes. They should possess particular knowledge of air craft and of the character of material which enters into air-craft construction and should be familiar with the methods and processes used by manufacturers in air-craft construction. One year's experience as a machinist in a factory constructing gas engines for automobiles or air planes, or as an inspector of air-plane or automobile engines, or one year's actual experience in flying is a prerequisite for consideration for this position. Until further notice, applications will be received at any time, and the papers will be rated immediately upon their receipt. Applicants must have reached their twenty-second birthday on the date of filing application. Apply for Form 1312.

SKINNER ENGINE CO., Erie, Pa., reports the death, on April 28, of the company's secretary and treasurer, Frank Connell.

DEFECTIVE VISION may be either a cause or a result of ill health, so that poor lighting can undermine a man's constitution.

Books and Catalogs

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES, is the title of Technical Paper 137, by Henry Kreisinger and others, which has just been issued by the Bureau of Mines of the Department of the Interior.

The main object of investigation was to determine the conditions governing the process of combustion in the fuel bed of a hand-fired furnace. The results of this investigation furnish data for correct design of coal-burning grates and furnaces and their efficient operation. They also cast light on the important problem of clinker trouble as related to fusibility of ash. They further indicate the possibility of a high rate of gasification of coal in gas producers.

The first part contains general information on the combustion of coal in furnaces. What combustion is and how the process of combustion takes place is explained, also how much air is needed to burn one pound of coal and how the air and the coal are brought together to effect combustion. The method of feeding coal and air in 4 types of commercial furnaces is shown and discussed.

The second part contains the description and the results of about 50 tests made in a small experimental hand-fired furnace, which was designed for an accurate study of the processes of combustion in the fuel bed. Provision was made for taking gas samples and temperature measurements at various depths in the fuel bed. Three kinds of fuels were tested in this furnace, namely, Pittsburgh coal, anthracite coal, and coke. The rate of combustion was varied from 20 to 185 lb. of fuel per square foot of grate per hour. Two thicknesses of fuel bed were used—6-in. and 12-in. The air supplied through the grate was measured with an orifice.

The third part discusses the investigations described in the second part of the report, and includes about 40 charts that show the composition of the gases and the temperature at different depths in the fuel bed of a hand-fired furnace, and various relations between the air supply and the rate of combustion.

Many deductions are drawn from the charts, and the significance of these deductions in the operation of industrial furnaces is shown. Many useful suggestions on the operation of such furnaces are offered.

The fourth part contains miscellaneous data on the composition of gases rising from the fuel bed of a hand-fired furnace under a steam boiler, a Murphy stoker, and a Jones underfeed stoker. It also contains a short discussion of the bearing of the results of the experiments on the operation of gas producers and explosions in boiler furnaces.

Copies of this technical paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

PROTECTIVE LIGHTING for Industrial Plants, Bulletin 30, Engineering Department, National Lamp Works of General Electric Co., has been published as a result of a number of requests for recommendations as to the proper use of artificial light about industrial plants for protective purposes during times of war. General principles are discussed, particularly minimizing of glare effects and distribution of light into direc-

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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PRACTICAL ENGINEER

AIR RECEIVERS AND MOISTURE TRAPS

For Standard Working Pressures

Number of Size	Diam. in Ins.	L. in Ft.	Contents Cu. Ft. (about)	Thickness of Shell Inches	Thickness of Heads Inches	Weight Lbs. (about)	Diam. of Safety Valve Ins.	Diam. of Inlet & Dis. V's Ins.	COMPRESSOR CAPACITY RECEIVER IS BEST ADAPTED FOR IN CUBIC FEET FREE AIR PER MINUTE
For Working Pressure up to 110 Pounds									
0	18	6	10	3/16	5/16	350	1	2½	90
00	24	6	18	7/32	5/16	575	1¼	2½	120
1	30	6	29	¼	3/8	950	1½	3	150
2	36	6	42	¼	3/8	1,000	1½	3½	150 to 200
3	36	8	56	¼	3/8	1,350	1½	4	200 to 300
4	42	8	77	9/32	3/8	1,750	2	5	300 to 500
5	42	10	96	9/32	3/8	2,000	2	6	500 to 700
5½	48	8	100	11/32	7/16	2,480	2½	6	500 to 800
6	48	12	150	11/32	7/16	3,000	2½	7	700 to 1,200
7	54	12	190	3/8	7/16	3,300	2½	8	1,200 to 2,100
7½	60	14	275	13/32	½	5,500	2½	9	2,000 to 3,000
8	66	18	437	7/16	9/16	7,500	2½	10	3,000 and over
9	24	6	18	7/32	5/16	625	1½	4	(These are only furnished horizontal style and are used as water traps in air lines.)
10	36	6	42	¼	3/8	1,100	1½	6	
10½	48	8	100	11/32	7/16	2,200	2½	6	

The tables of dimensions given in this list refer to either Vertical or Horizontal patterns, excepting for sizes Nos. 9, 10, and 10½ which are furnished only in Horizontal patterns, and are used as water traps in air lines. Vertical Receivers are usually preferred to Horizontal, on account of the small amount of floor space that they occupy.

Sizes 0 and 00 are suitable for use in machine shops and granite yards, for small air lifts, or anywhere in connection with a small air compressor. They are made of the best steel, single riveted, and tested to 165 Lbs. water pressure. Fixtures generally include Safety Valve, Pressure Gauge, Drain Cocks, and tapping for inlet and discharge pipes.

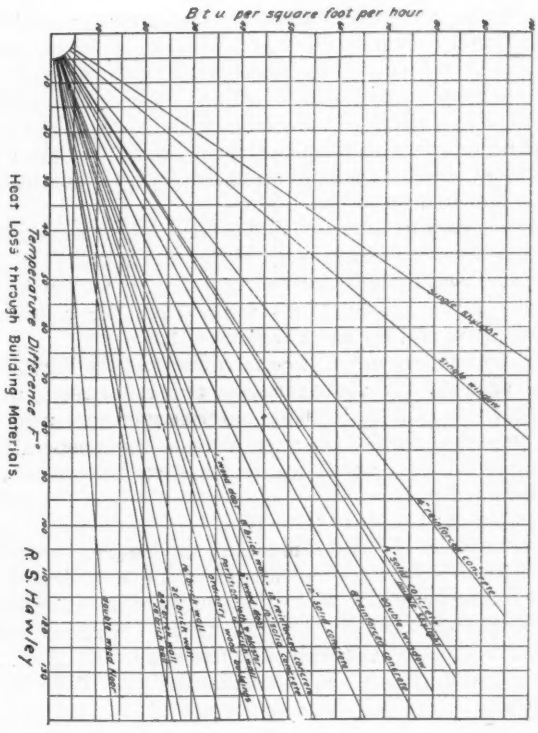
On Sizes Nos. 1 to 10½ inclusive fixtures generally include Manhole, Safety Valve, Pressure Gauge, Drain Cocks and from Nos. 4 to 8 inclusive and Nos. 10 and 10½ Flanges for inlet and discharge pipes.

When considering the use of Nos. 9 and 10 or 10½ for moisture traps, always use Size No. 10 or 10½ with 6-inch connections if air pipe is over 4 inches.

The sizes given for inlet and discharge openings are MAXIMUM. When necessary, they may be reduced on the smaller sizes by the use of 'reducers' and on Sizes No. 4 and up (which have flange connections), by the use of smaller flanges.

HIRSCHBERG.

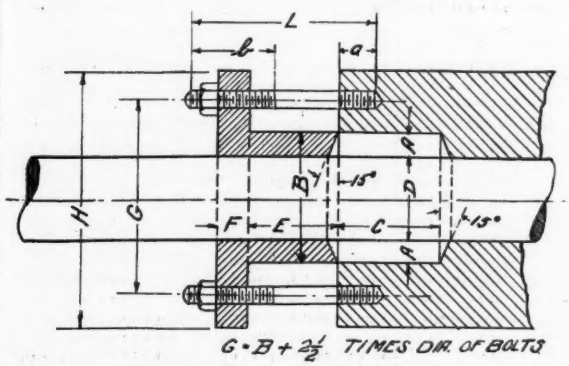
PRACTICAL ENGINEER



PRACTICAL ENGINEER

HYDRAULIC STUFFING BOXES

FOR PRESSURE OF 500 LB. PER SQ. IN.



D	A	B	C	E	F	G	H	STUD BOLTS No. of Bolts	Dia.	L	a	b
1	1/4	1-1/2	1-1/2	3/4	1/2	2-3/4	4	2	1/2	2-1/2	3/4	1-1/4
1-1/4	1/4	1-3/4	1-3/4	7/8	1/2	3	4-1/4	2	1/2	2-1/2	3/4	1-1/4
1-1/2	1/4	2	1-1/2	1	5/8	3-1/4	4-1/2	2	1/2	2-3/4	3/4	1-1/2
1-3/4	3/8	2-1/2	2-1/4	1-1/4	5/8	3-3/4	5	2	1/2	3	3/4	1-3/4
2	3/8	2-3/4	2-1/4	1-3/8	3/4	4	5-1/4	2	1/2	3-1/4	3/4	1-3/4
2-1/4	3/8	3	2-3/4	1-1/2	3/4	4-1/2	6-1/4	4	5/8	3-1/2	1	1-3/4
2-1/2	1/2	3-1/2	3	1-5/8	3/4	5	6-3/4	4	5/8	4	1	2-1/4
2-3/4	1/2	3-3/4	3	1-7/8	7/8	6-1/4	7	4	5/8	4	1	2-1/4
3	1/2	4	3	2	7/8	6-1/2	7-1/4	4	5/8	4	1	2-1/4
3-1/2	5/8	4-3/4	3-3/4	2-3/8	7/8	6-1/4	8	4	5/8	4-1/2	1	2-3/4

PRACTICAL ENGINEER

TABLE OF CARRYING CAPACITY FOR BUS BARS

By P. M. GALLO.

Width of Strip Ins.	Thickness of Strip, Inches. 1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4
A	B									
1/8	40	53	66	79	92	105	119	131	157	184
5/8	49	66	82-1/2	97-3/4	113	130	144	157-1/2	186-1/2	215-1/2
3/4	58	79	99-1/2	116-1/2	134	151	169-3/4	184	216-1/2	249
7/8	67	92	114-3/4	135-1/4	155	174	195	210-1/2	246	281-1/2
1	76	105	131	154	176	197	218	237	275-1/2	314
1-1/8	85	119	147-1/4	172-3/4	197	220	242-1/2	263-1/2	305-1/2	346-1/2
1-1/4	94	132	163-1/2	191-1/2	218	245	267-1/2	290	336	379
1-5/8	103	145	180	210-1/4	239	266	292	316-1/2	364-1/2	411-1/2
1-1/2	112	158	196	229	260	289	317	343	394	444
1-3/4	130	184	229	266-1/2	302	335	366-1/2	395	453-1/2	509
2	148	211	261	304	344	381	416	449	513	574
2-1/4	166	237-1/2	294	341-1/2	386	427	466	502	572	639
2-1/2	184	264	326	379	428	473	515-1/2	555	631-1/2	704
2-3/4	202	291	359-1/2	416-1/2	470	519	566	609	690-1/2	769
3	220	317	391	454	512	566	614-1/2	661	750	834
3-1/2	256	370	456	529	596	657	714	767	868-1/2	964
4	292	423	521	604	680	750	813	873	987	1094
4-1/2				679	764	843	913	979	1105-1/2	1224
5				754	849	934	1013	1085	1224	1354
6				904	1016	1118	1213	1297	1461-1/2	1614
8										
A	9	13.8	16.85	18.78	21	23	24.8	26.5	29.65	32.5

HEATING DATA

For stone wall multiply the value found from the chart by 1.25.

For hollow walls of brick or stone multiply by 0.85. For fair construction increase the results by 20 per cent. For poor construction increase results by 30 per cent.

Between temperatures of 40 and 15 deg. above zero, wind with a velocity of one mile an hour is equivalent to one degree drop in temperature; between 15 above and 20 below zero, one mile of wind movement is equivalent to 1.15 deg. drop in temperature.

For walls with north exposure multiply the radiation found from the chart by 1.32; for east walls, by 1.12; for south walls, 1.00; for west walls, 1.20; for northeast walls, 1.22; for northwest walls, 1.26; for southeast walls, 1.06, and for southwest walls, 1.10.

The temperature of a room is taken at the breathing line or about 5 ft. above the floor, so that for rooms with ceilings over 12 ft. high the mean temperature used in calculations should be greater than the temperature desired at the breathing line. Rietschel gives the formula:

$$t\,m = t\,[1 + 0.017\,(h - 10)].$$

In which t m = average mean temperature, t = specified room temperature at breathing line, h = height of the ceiling or outside wall. In calculating radiation from ceilings approximately 15 per cent should be added to the specified inside temperature for rooms up to 15 ft. in height and 30 per cent for ceiling heights of 20 ft. or more.

COOLING WATER REQUIRED FOR AFTERCOOLERS, INTERCOOLERS, AND AIR CYLINDER JACKETS

Gallons of Water per 100 Cu. Ft. actual free air for different water temperatures

	60 Degrees	70 Degrees	80 Degrees	90 Degrees
1. Aftercooler or intercooler separate (80–100 Lbs. 2-stage compression)	2.5	3	3.5	4
2. Intercooler and jackets in series (80–100 Lbs. 2-stage compression)	2.9	3.4	4.0	4.5
3. Aftercooler for 80–100 Lbs. single-stage compression	4.0	4.5	5.2	6.0
4. Both low- and high-pressure jackets with water supply separate from intercooler (80–100 Lbs. 2-stage comp.)	0.85	1.0	1.2	1.4
5. Jacket for single-stage comp. 40 Lbs. air pressure	0.5	0.6	0.7	0.9
6. Jacket for single-stage comp. 60 Lbs. air pressure	0.6	0.7	0.8	1.0
7. Jacket for single-stage comp. 80 Lbs. air pressure	0.7	0.8	0.9	1.1
8. Jacket for single-stage comp. 100 Lbs. air pressure	0.8	0.9	1.0	1.2

With the amounts of water given in the above table, it is expected that the temperature of the air leaving the intercooler or aftercooler will be within 20 degrees of the temperature of the water entering the cooler for ordinary working conditions; namely, when the cooler is handling air from a two-stage compressor, 100 Lbs. work, and when the initial water temperature is around 70 degrees F.

Less water may be used without causing a very appreciable increase in this 20-degree temperature difference. To get good aftercooling, it is better to have a moderate quantity of cold water rather than an unlimited supply of water at a high temperature. In cases where water is very scarce, compressors may be run without material loss with considerably less water than shown in the table, especially for the jackets.

Hirschberg.

NOTES ON TABLE OF CARRYING CAPACITY FOR BUS BARS

A—Additional amperes for every ⅛ in. increase in width.

This table shows current capacity for a temperature rise of 20 deg. F. above surrounding air. Bars reduced ½ their thickness for a given current, raises the temperature about 50 deg. F. above surrounding air, intermediate thickness give intermediate temperatures. Doubling the current raises the temperature about 100 deg. F. above surrounding air.

For aluminum use bars twice thickness required for copper, width = 5 times new thickness and over.

For iron use 6 times thickness required for copper, width = 12 times new thickness and over.

Allow 100 amp. per sq. in. surface contact for bus bars.

Allow 60 to 75 amp. per sq. in. surface contact for knife switches.

For bus bars under 2 in. wide, 1 bolt may be used; for 2 and over use 2 or more smaller bolts.

Volts lost per foot at 150 deg. F. =

$$\frac{\text{Amperes} \times .0000096}{\text{width by thickness.}}$$

Volts lost per foot at 150 deg. F. for round rods or wires =

$$\frac{\text{Amperes} \times .00001222}{\text{Diameter squared.}}$$

HYDRAULIC STUFFING BOXES (Continued)

								STUD BOLTS			
D	A	B	C	E=F	F	G	H	No. of Bolts	Dia.	L	a	b
4	5/8	8-1/4	3-3/4	2-5/8	1	7	9	4	3/4	4-3/4	1-1/8	2-3/4
4-1/2	5/8	8-3/4	3-3/4	2-7/8	1	7-1/2	9-1/2	4	3/4	4-3/4	1-1/8	2-3/4
5	3/4	6-1/2	3-3/4	3-1/4	1	8	10	4	3/4	4-3/4	1-1/8	2-3/4
5-1/2	3/4	7	4-1/2	3-1/2	1	8-3/4	10-3/4	4	3/4	5	1-1/8	3
6	3/4	7-1/2	4-1/2	3-3/4	1-1/8	9-1/2	11-1/4	4	3/4	5-1/2	1-1/8	3-1/4
6-1/2	3/4	8	4-1/2	4	1-1/8	10-1/4	12-1/2	6	7/8	5-1/2	1-1/4	3-1/4
7	3/4	8-1/2	4-1/2	4-1/4	1-1/8	10-3/4	13	6	7/8	5-1/2	1-1/4	3-1/4
7-1/2	3/4	9	4-1/2	4-1/2	1-1/8	11-1/4	13-1/2	6	7/8	5-1/2	1-1/4	3-1/4
8	7/8	9-3/4	4-1/2	4-7/8	1-1/4	11-3/4	14	6	7/8	5-3/4	1-1/4	3-1/4
8-1/2	7/8	10-1/4	4-1/2	5-1/8	1-1/4	12-1/4	14-1/2	6	7/8	5-3/4	1-1/4	3-1/4
9	7/8	10-3/4	5-1/4	5-3/8	1-1/4	12-3/4	15	6	7/8	6-1/4	1-1/4	3-3/4
9-1/2	7/8	11-1/4	5-1/4	5-5/8	1-1/4	13-3/4	16-1/4	6	1	6-1/2	1-1/2	3-3/4
10	7/8	11-3/4	5-1/4	5-7/8	1-3/8	14-1/4	16-3/4	6	1	6-3/4	1-1/2	4
10-1/2	7/8	12-1/4	5-1/4	6-1/8	1-3/8	14-3/4	17-1/4	6	1	6-3/4	1-1/2	4
11	7/8	12-3/4	5-1/4	6-3/8	1-3/8	15-1/4	17-3/4	6	1	6-3/4	1-1/2	4
11-1/2	7/8	13-1/4	5-1/4	6-5/8	1-3/8	15-3/4	18-1/4	8	1	6-3/4	1-1/2	4
12	1	14	5-1/4	7	1-1/2	16-1/4	18-3/4	8	1	6-3/4	1-1/2	4
13	1	15	5-1/4	7-1/2	1-1/2	17-1/2	20-1/2	8	1-1/8	7-1/4	1-3/4	4
14	1	16	5-1/4	8	1-1/2	18-1/2	21-1/2	8	1-1/8	7-1/4	1-3/4	4
15	1	17	6	8-1/2	1-1/2	19-3/4	22-1/2	8	1-1/8	7-1/2	1-3/4	4-1/4
16	1	18	6	9	1-5/8	20-3/4	23-1/2	8	1-1/8	7-1/2	1-3/4	4-1/4
17	1	19	6	9-1/2	1-5/8	21-3/4	24-1/2	8	1-1/8	7-1/2	1-3/4	4-1/4
18	1	20	6	10	1-5/8	22-3/4	25-1/2	8	1-1/8	7-1/2	1-3/4	4-1/4
19	1	21	6	10-1/2	1-5/8	24	27	8	1-1/4	8	2	4-1/4
20	1	22	6	11	1-5/8	25	28	12	1-1/4	8	2	4-1/4
21	1	23	6	11-1/2	1-5/8	26	29	12	1-1/4	8	2	4-1/4
22	1	24	6	12	1-3/4	27	30	12	1-1/4	8	2	4-1/4
23	1	25	6	12-1/2	1-3/4	28	31	12	1-1/4	8	2	4-1/4
24	1	26	6	13	1-3/4	29	32	12	1-1/4	8	2	4-1/4

P. H. Gallo

tions where it is most useful. Special suggestions are offered for plants centrally located and for those in outlying districts and surrounded by an expanse of unoccupied land. The general considerations discussed may be applied also in the safe-guarding of the bridges, docks, railway centers and other points of strategic importance.

THE GROWING INTEREST in special acid resisting alloys and the many uses found for them have stimulated both the search for efficient materials of this nature and the study of the causes underlying their inertness. As a result of previous studies at the University of Illinois, it has been shown that the almost perfect insolubility of certain alloys in nitric and other acids seems to be conditioned upon a proper mixture of chromium, copper and nickel, together with smaller quantities of such added metals as tungsten or molybdenum.

The University of Illinois Engineering Experiment Station has just completed a preliminary systematic study of the alloys of chromium, copper and nickel, and their properties. The work has been under the direction of Dr. D. F. McFarland, Assistant Professor of Applied Chemistry, and Dr. O. E. Harder, Fellow in Chemistry.

As a result of the studies mentioned, methods have been developed for making castings of alloys of chromium, copper and nickel; and 21 binary and 30 ternary alloys have been prepared. Physical and chemical tests have been made to determine the properties of the various alloys. More than 300 corrosion tests have been made to measure the effects of acids upon the metals. In general, the results indicate that certain of the alloys of chromium, copper and nickel give promise of becoming of great commercial importance not only in the construction of laboratory apparatus, but in manufacturing and chemical processes in which the handling of acids is involved.

Copies of Bulletin No. 93, containing the results of these tests may be obtained without charge by writing C. R. Richards, Director of the Engineering Experiment Station, Urbana, Ill.

BULLETINS have been received from The Automatic Reclosing Circuit Breaker Co., 38 N. Water St., Columbus, Ohio, as follows: Bulletin No. 18 illustrates some typical installations of automatic reclosing circuit breakers; Bulletin No. 21 describes the theory, operation and construction of the company's Type I automatic reclosing circuit breaker, designed for individual motor protection, and built in capacities of 50 and 100 amp.

A NEW FOLDER from National Regulator Co., 208 S. Jefferson St., Chicago, describes a modified thermostat, 5¾ by 2¼ by 1¾ in., reducing in size only the general dimensions of the company's thermostatic device and maintaining the original sensitive element and other prominent features of its design. Metaphram valves and motors manufactured by the company are also mentioned.

WESTINGHOUSE electric fans for 1917 season are described and illustrated in Catalog 8-A, just issued by the Westinghouse Electric & Mfg. Co. The new developments in the line of Westinghouse fans embrace the "Whirlwind," an 8-in. fan, retailing at $8; a 10-in. type and an electrolier attachment. All of the fans are illustrated and described in considerable detail in this publication.

SAFETY and floor reading water gage device for boilers, manufactured by Reiber-Gibbs Co., 2516-22 Smallman St., Pittsburgh, Pa., is the subject of a circular from that company.

The "Safety First" gage glass protector is also illustrated in an accompanying circular.

QUARTERLY BULLETIN No. 88 of General Fire Extinguisher Co., 277 West Exchange St., Providence, R. I., discusses some of the worst catastrophes among recent fires and refers particularly to the use of Grinnell automatic sprinkler systems in cotton mills and metal working concerns.

S. K. F. BALL BEARINGS and their application to mining locomotives, dynamometers, machine tools, woodworking machines, fans, textile motors and flour mills are described in a catalog recently received from S. K. F. Ball Bearing Co., Hartford, Conn.

THE PNEUMERCATOR, an instrument of precision for indicating the level of any liquid and its weight or volume in any tank, standpipe or reservoir is discussed in an illustrated pamphlet from Pneumercator Co., Inc., 118 Liberty St., New York City.

RECENT BULLETINS from Manistee Iron Works Co., Manistee, Mich., are as follows: Bulletin 50, on the subject of Rees Roturbo patent rotary jet condensers; Bulletin 52, on Rees Roturbo patent rotary jet vacuum pumps for surface condensers.

RICKARD & SLOAN CO., INC., 20 Vesey St., New York, has recently issued a beautifully executed book, "A Mark and Its Import," which describes that company's service to advertisers and illustrates examples of its work, many of them printed in colors.

THE HOPPES MFG. CO., Springfield, Ohio, is sending out its latest general catalog, No. 70, illustrating and describing the Hoppes feed water heaters, live steam purifiers, steam separators, oil eliminators, exhaust heads and V-notch water meters.

BULLETIN NO. 41,514, of Sprague Electric Works of General Electric Co., deals with single-phase varying-speed motors.

A new electric fan booklet has also been published by that company.

BALL BEARINGS in Machine Tools are the subject of a pamphlet comparing Hess-Bright ball bearings with earlier types and discussing the origin of the annular type. The manufacturer is The Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia.

THE STORY of a Can of Corn, related in a pamphlet from Taylor Instrument Cos., Rochester, N.Y., giving the general procedure from the growing corn to the finished product, includes the regulation of canning temperatures with Tycos thermometers and regulators.

CROUSE-HINDS CO., Syracuse, N. Y., lately issued Bulletin No. 302, which describes, illustrates and lists the various types of Crouse-Hinds Imperial flood light projectors and reflectors.

ENGINEERING DEPARTMENT Bulletin 28, National Lamp Works of General Electric Co., presents in a general way the essentials of good show-window lighting, emphasizing the possibilities of light direction and color, and gives practical installation suggestions.

THE EXCLUSIVE manufacturing and selling rights of the Turbo-Gear formerly manufactured by the Turbo-Gear Co., Inc., of Baltimore, Maryland, have recently been acquired, through consolidation, by the Poole Engineering & Machine Co., also of Baltimore.

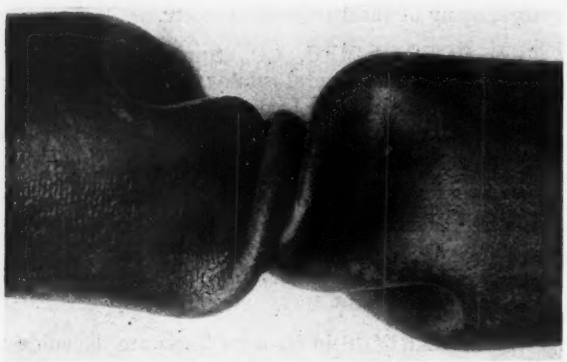
The Turbo-Gear has, through long and severe service, proved to be the most highly developed speed transforming device on the market, for use with high-speed electric motors, steam turbines and other prime movers or driving machines which require a different speed for the driven unit.

A descriptive catalog can be obtained by application to the Poole Engineering & Machine Co., Baltimore, Md.

Trade Notes

BURKE ELECTRIC CO., of Erie, Pa., has opened a Washington branch sales office in charge of J. N. Perry, at 424 Union Trust Building, exclusively for United States Government service during the war.

AT FIRST GLANCE, the accompanying illustration looks like a piece of rubber—but it isn't. It's a piece of 8-in. "National" line pipe after being subjected to a torsional stress of 713,000 inch-pounds. Eight-inch line pipe, as you may remember, weighs in the neighborhood of 29 lb. per ft., and the walls have a thickness of approximately ⅓ in. So it can readily be understood that the quality of the material in this pipe must have been first-class to withstand the enormous strain involved.



TO PROVIDE FACILITIES for its greatly increasing business, The Lunkenheimer Co., of Cincinnati, has recently completed a new foundry occupying an area of 36,000 sq. ft. and a pattern storage building with an area of 18,000 sq. ft., 4 stories high. Both are of reinforced concrete. The foundry has ample wash rooms for employes, provided with shower baths and individual lockers. The floor is of creosoted wood block and equipment includes a cupola with capacity of 10 T. an hour, revolving furnaces for ferrous alloys, tilting crucibles mounted on trucks, 6 traveling cranes and a concrete storage for materials. Non-ferrous castings are made in another building.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

SEMI-MONTHLY

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By young man 21 yrs. in a power plant of 1000 kw. or more where there is a good chance for advancement. Not particular about wages or kind of work to start with. Have had a year's experience night engineer in 25 kw. plant and one year as head of 200 hp. heating plant. Can furnish best of references. Strictly sober. Am anxious to learn, but patient. Address Box 200, Devil's Lake, N. D. 4-15-3

POSITION WANTED—As chief engineer. Have had 10 years' practical experience. Especially qualified to handle the plant on an efficiency basis, reducing coal consumption and operating costs. Must locate in Chicago. Presently employed, but have good reasons for desiring a change. Address Box 479, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-15-1

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 5-15-1

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-15-1

POSITION WANTED—Fireman with first-class Mass. license would like to locate near Boston, Mass. Day work, 8 or 10-hour day. Sober and reliable. Best of references. Address R. C., 17 Cozenore St., Boston, Mass.

POSITION WANTED—By engineer competent to operate Corliss and high speed engines and turbines. Familiar with a.c. and d.c. generators and refrigeration. Age 27. Married. Sober. Desire position around New York. Address A. Kahel, 233 S. 4th St., Brooklyn, N. Y.

POSITION WANTED—By man 30 years old, good habits, married, with 6 years' experience in steam electric plants. Would like position as engineer in plant of 2500 kw. capacity or more, where I can advance myself. Address Box 471, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-1-2

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-1-2

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 4-1-4

POSITION WANTED—As fireman or oiler in large plant; 3 years' experience as fireman, 18 months as assistant engineer. Married. Strictly sober. Prefer Southern States. L. C. Drake, Cambridge City, Ind. 5-1-2

POSITION WANTED—as chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 5-1-2

POSITION WANTED—By young man, 23 yrs. old, as fireman or oiler in ice and electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 4-15-3

POSITION WANTED—As engineer in small power plant. Five years' experience as engineer in grain elevator. Good mechanic. Steady and sober habits. Single. 28 years old. Central states preferred. Box 115, Walcott, Iowa. 5-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Men calling on the steam trade to introduce and sell "The worst enemy boiler scale ever had." Good territory and a good proposition open to live men who will work. The Rodgers-Collins Co., Pontiac Bldg., St. Louis, Mo. tf.

For Sale

FOR SALE—Steam engine for generator, 200 to 380 hp. Harrisburg cross compound automatic engine on sub-base. Cylinders 14 by 26 by 18 in. Wheel 72 by 27 in. face. First-class operating condition. Dimensions 8 by 12 ft. Sell right. "Machinery," 294 Washington St., Office 706, Boston, Mass. 5-15-1

FOR SALE—Four-inch standard brass drop pipe in 5-20 ft. length, complete with brass guides and rods, all practically new. Owner putting down new well. The Brenneman Baking Co., Columbus, Ohio. 5-15-2

FOR SALE—One 45-hp. Mass. standard Ames Iron Works vertical boiler, 48 in. diameter by 10 ft. 6 in.; never used. The Shaffer-Marsh Company, 35 High St., Hartford, Conn. 5-1-2

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Here's a true story sent to us by one of our subscribers. It is a convincing argument of the necessity of engineers posting themselves on new equipment and getting the complete literature offered by the advertisers.

Hearing of the new turbine units and oil burning appliances which were recently installed in the Middlesex Power & Light Co., and passing through the city, I seized a few minutes to run over and see my old time friend, Jerry, the chief of the plant. Imagine my surprise when I learned that Jerry no longer reigned, that a new chief filled the billet. "Where's Jerry, and why did he resign?" I asked the former assistant engineer, who now had Jerry's job. This was the story:

"When the company put in these new units, some trouble was experienced in getting them to run smoothly, so the builders sent their men here to instruct Jerry about the management of them. Jerry was bull headed, and thought he knew as much about steam engineering as the young cub who was sent by the turbine builders to instruct him, and I guess that's where the trouble started. You know he worked here for sixteen years, and had been pretty successful. When the president sent for him and asked what the trouble was that the turbines did not produce, he made all sorts of excuses with the result that an investigation was made by the builders, and a consulting engineer, who turned in a report that Jerry was not adapted, nor able to adapt himself to the management of the new units. They said, 'the poor man can't be told anything. He feels that he knows it all, and is so satisfied with himself that our men can't impress certain important details upon him.' The result was that I was asked if I could learn to handle the new units, and as I had been studying them, I readily agreed to try. Jerry was given a chance, but he did not make good, and rather than see someone else put over his head, he quit."

After hearing this, I have thought that there are many more engineers who are just like Jerry. One reason for it is that they do not try to keep posted. They don't read power plant papers, or go visiting other plants. They have grown so hand and foot to their specific plant that new developments in the power field come as a sort of shock to them, and they are unable to adapt themselves to the new conditions. Progressively they are a failure. They have become gear of an odd pitch unable to mesh in the wheels of modern progress.

While no doubt, Jerry still retained his full power of usefulness in the old field of reciprocating engines, and coal burning boilers, and could get another job, it must have been a sad blow to have to give up the position as chief in a plant where he had worked for sixteen years. The firm had liked Jerry, and was reluctant to let him go, remembering that he had been a good man in the old days. They had hoped he would apprentice himself to the new field, but when they found that he was turning the care of the new units over to his assistant, letting this younger man shoulder his responsibility, they no doubt believed it was proper to change places. How much better it would have been to hear of the firm congratulating Jerry on the successful management of the new units, and his ability to adapt himself to the new conditions.

Take a census of your own abilities. Can you, if the change comes, adapt yourself to the new power equipment in a way that will open the firm's eyes? The best insurance that you can have against being dropped when the change comes is to use the moments ordinarily frittered away. Get acquainted with new developments, first, by reading and remembering all you can of the latest equipment adopted; second, visit the new plants, and talk with the engineers in charge; third, never be satisfied that you know enough about the whole field to get by. Always be on the lookout for more pointers, for there is always something new, if it is only the other fellow's views. Hold your own, and a little bit more; make each day count for a little more than what the other fellow does. It will take big efforts to do it—all worth while things do.